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# EASTERN BRANCH

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Abstracts of papers presented at sessions, workshops, and symposia on September 14, 15 and 16, 1977.

The Ecology of the Aphid Predator, *Aphidoletes aphidimyza* (Cecidomyiidae: Diptera), and the Effect of Pesticides on its Survival in Apple Orchards. —R. G. Adams and R. J. Prokopy, Univ. Massachusetts, Amherst, MA 01003.

Larvae of *Aphidoletes aphidimyza* are bright orange colored maggots that feed on many species of aphids. From 1974 through 1976, this cecidomyiid was by far the most abundant summer predator of the apple aphid, *Aphis pomi* DeGeer (Aphidae: Homoptera) in an unsprayed Massachusetts apple orchard. It was responsible for high apple aphid mortality and dramatic population reductions. Apple terminals were caged with various *Aphidoletes* to apple aphid density ratios to study feeding behavior of the larvae. In every case, aphid colonies caged with cecidomyiids were either reduced or decimated within 12 days. The mean number of aphids killed per cecidomyiid was 28, ranging from 4 to 65 depending on predator and prey abundance. Emergence cage studies showed that *Aphidoletes* overwinters in the soil beneath apple trees, but eclosion does not occur until mid-June. Therefore, for season-long control, apple aphid populations need to be maintained below injurious levels until *Aphidoletes* arrives in June. To determine the susceptibility of *Aphidoletes* to orchard sprays, toxicity studies were conducted on eggs using the slide dip method. Egg mortality was generally low with the exception of the Guthion treatment, where mortality was high. However, a few materials that were of low toxicity to eggs were highly (Systox) or moderately (Thiodan and Imidan) toxic to young larvae hatching from treated eggs. Total mortality for eggs and larvae combined was high for Guthion and Systox, moderate for Thiodan and Imidan, and low for Plictran, Omite, and Zolone.

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Transmission of Pierce's Disease of Grape by Sharpshooters (Homoptera: Cicadellidae) in Florida.—W. C. Adlerz and D. L. Hopkins, Univ. Florida, IFAS, ARC, Leesburg, FL 32748.

Five species of sharpshooters transmitted the Pierce's disease pathogen from diseased to healthy grape in controlled tests. Three of the species breed on grapes, 2 large sharpshooters that feed on woody tissue, and a smaller one that feeds on leaves. The 2 large sharpshooters *Homalodisca coagulata* and *Oncometopia nigricans* were randomly collected in the ARC Leesburg vineyard from September 1975 through August 1976 and were caged, in 10-insect lots where possible, on indicator plants to test their natural infectivity. Test quantities of *H. coagulata* were not available from November through April and *O. nigricans* was absent from October through February. All 12 lots of *H. coagulata* collected May–October were noninfective. Of 22 lots of *O. nigricans* collected in the vineyard March–Sep-

tember, 3 consecutive lots collected the last 2 weeks in April and the first week in May were infective. Population counts of *O. nigricans* and *H. coagulata* were made weekly on 100 feet of vineyard row in 10 randomly selected segments. Population levels of *Graphocephala versuta*, the leaf feeder, were monitored weekly with 13 × 25 cm sticky boards hung from the trellis wires at various locations in the vineyard. *O. nigricans* sharpshooters migrated to the vineyard in large numbers in the spring and their numbers declined during summer. They were the only sharpshooters on grape in large numbers at the time of Pierce's disease natural spread in 1976. *H. coagulata* populations were initiated in late May and peaked in July, while *G. versuta* populations were initiated in May and peaked in September.

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Observations on the Blotch Leafminer, *Agromyza frontella* (Rondani) (Diptera: Agromyzidae) in Massachusetts Alfalfa.—J. T. Andaloro and T. M. Peters, Univ. Massachusetts, Amherst, MA 01003.

The alfalfa blotch leafminer and its damaging effects on alfalfa were first detected in western MA in 1968. Since then *Agromyza frontella* has been reported over most of the northeastern U.S. and also in Quebec and in Nova Scotia. In MA, overwintering adults emerge about 15 May, completing 3 generations throughout the season. Adult females puncture new alfalfa leaflets with their ovipositor (pinholing) and imbibe exuded sap. Up to 75% of the leaflets observed had greater than 5 pinholes and 100/leaflet is common. Heavily punctured leaflets are prone to infection by pathogens and may abscis before harvest. The female also makes egg laying punctures through the lower epidermis of new leaflets where she slips an oval white egg into the spongy mesophyll. In Franklin County, peak egg densities of 29 eggs/54 cm high stem were estimated during the 2nd generation. Upon hatching, the 1st instar mines its way to the palisade layer, readily visible through the upper epidermis. By the 3rd (last) instar, the mine has progressed from a linear stage to an increasingly large blotch. Data taken on a heavily infested field (32 mines/60 cm high stem) in Franklin County during August 1976 indicated that less than 7% of the mines covered more than ⅓ of the leaflet. The majority of these leaves turn brown, dry, and abscis after the larvae have exited to pupate in the soil. Indigenous parasitoids appear to be ineffective in suppressing leafminer populations.

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Taxonomy and Phylogeny of the Kermesidae, or Gall-like Scale Insects in the Nearctic Region Based on First Instars (Homoptera: Coccoidea).—R. G. Baer and M. Kosztarab, VPI and SU, Blacksburg, VA 24061.

The genera *Kermes* and *Olliffiella* are included in the Kermesidae which are principally found on oak. Thirty *Kermes* species have been previously described, based primarily on external characteristics of the adult females. The descriptions overlap considerably and no suitable keys have been prepared. These old females are considered worthless and cannot be slide-mounted because of their hard, sclerotized external character. First instars entrapped under or in the females, on the buds and twigs and in bark crevices were studied microscopically to estimate the number of species which actually exist. *Olliffiella* is considered primitive morphologically. Branching from a common stem with the *Olliffiella*, *Kermes* has divided into 3 main groups based on morphology. These groups subdivide into a total of 10 morphologically distinct species or species groups. Of these 10, 2 are new. The known habitat of *Olliffiella* and 1 main *Kermes* group is considered primitive because of its association with the leaves. The other 2 main groups of *Kermes* are found on different parts of the tree, indicating an evolution toward a more protected habitat. Studies based on correlations between morphology and habitat have resulted in the probable phylogenetic interpretation of *Kermes* and *Olliffiella*.

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Evaluation of Bluegrasses for Tolerances to *Blissus leucopterus hirtus* (Hemiptera: Lygaeidae).—P. B. Baker, Univ. Maryland, College Park, MD 20742 and R. H. Ratcliffe, USDA, Beltsville, MD 20705.

Cultivars of Kentucky bluegrass (*Poa pratensis* L.) were evaluated in the laboratory for tolerance to the chinch bug (*Blissus leucopterus hirtus* Montandon). Chinch bugs were reared on corn stem sections in ½-pint cardboard containers. Corn was cut into 7.5-cm sections and coated with paraffin at one end, after which sections were surface sterilized in 2% chlorox solution and placed in containers with 1st instar nymphs. Sections were changed weekly. Development time from egg eclosion to adult was 4–6 weeks. Grass cultivars were evaluated for tolerance to adult feeding when approximately 1 month old. Selections were seeded in 15.2-cm pots in 4 tufts (groups) of seed/pot. Tufts were thinned to 5 plants 7–10 days prior to infestation and cut to 3.8 cm the day of infestation. During infestation plants were confined within a plastic cylindrical cage 10 × 20.3 cm high. The cage was divided longitudinally by a flat piece of clear plastic glued between the halves of the cylinder. Adults were placed in one side of the cage; the other side served as an uninfested check.

Following infestation, regrowth, yield, percent dry matter, root development, plant survival and tillering were recorded. At infestation rates of 2 adults/plant or higher, plants were severely injured and top and root growth significantly reduced. There were also significant differences in regrowth, yield, percent dry matter and plant survival among cultivars, indicating that these may be useful criteria for measuring tolerance.

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Virulence of *Autographa* baculovirus (NPV) to *Trichoplusia ni* (Hübner) (Lepidoptera: Noctuidae): Effects of Purification Method and Bioassay Food Source.—D. G. Baugher, W. G. Yendol, and R. Thomas, The Pennsylvania State Univ., University Park, PA 16802.

Polyhedral inclusion bodies (PIBs) of *Autographa californica* nuclear polyhedrosis virus (AcNPV) were propagated in *Trichoplusia ni* larvae and purified by 3 methods. Field stock AcNPV was prepared by maceration, differential centrifugation and pelleting through 40% sucrose. Dried field stock AcNPV was prepared by trituration, differential centrifugation, pelleting through 40% sucrose, and air-drying the final pellets. Laboratory stock AcNPV was prepared by trituration, differential centrifugation, sequential pelleting from 4 M urea, $dH_2O$, 1.0% sodium dodecyl sulfate, 0.5 M NaCl, and banding in 40–65% sucrose gradients. Feeding phase 8-day posteclosion 4th instar larvae were individually fed doses of AcNPV on 0.25 $cm^2$ cabbage disks and/or 100 $mm^3$ diet plugs. Larvae were then reared individually on diet until death or pupation. Probit-mortality log-dosage lines were determined for each preparation. AcNPV purified by different methods and bioassayed on different food sources showed a wide range of activity, with $LD_{50}$s of 10–345 PIBs/larva. Laboratory stock AcNPV was more virulent than field stocks on the same food sources when $LD_{50}$s were compared. Virus ingested on diet plugs was more virulent than virus ingested on cabbage disks. Although $r^2 > 93\%$ for all regressions, laboratory stock AcNPV showed least variability. Dried field stock virus was least virulent when compared to other stocks that were administered to diet plugs.

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EL-494 A New Molt-inhibiting Insecticide.—D. F. Berard, J. L. Miesel, B. A. Scott, Lilly Research Laboratories, Eli Lilly & Company, Greenfield, IN 46140.

EL-494, *N*-[[[5-(4-bromophenyl)-6-methyl-2-pyrazinyl]-amino]carbonyl]-2,6-dichlorobenzamide, is a new molt-inhibiting insecticide. Acting as a stomach poison, it is effective in controlling a variety of insect pests. Laboratory studies with EL-494 have demonstrated 100% control of southern

armyworm *Spodoptera eridania* larvae at 1–5 ppm, Egyptian cotton leafworm *Spodoptera littoralis* larvae at 10 ppm, and greater wax moth *Galleria mellonella* larvae at 50 ppm, diet incorporated. Diptera controlled by EL-494 include yellow-fever mosquito *Aedes aegypti* at 0.1 ppm, water incorporated, and housefly *Musca domestica* at 50 ppm, diet incorporated. While providing only 75% control of Mexican bean beetle *Epilachna varivestis* at the 2nd to 3rd larval instar molt at 1,000 ppm, EL-494 provides 100% control during the larval to pupal molt at 25 ppm. The increased sensitivity of last stage larvae to EL-494 has also been demonstrated with southern armyworm. Complete reproductive suppression has been observed after Mexican bean beetle and housefly adults were fed EL-494. Treated adults produce eggs that fail to undergo proper egg eclosion. Field tests have also demonstrated that EL-494 has provided good-to-excellent control at 0.28 kg/ha of imported cabbageworm *Pieris rapae* and cabbage looper *Trichoplusia ni* on broccoli and cabbage, velvet-bean caterpillar *Anticarsia gemmatalis* on soybean and fall armyworm *Spodoptera frugiperda* on sweet corn.

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Components of the Aggregating Pheromones of *Pissodes* (Coleoptera: Curculionidae) Weevils.—D. C. Booth, A. Claesson, G. N. Lanier and R. M. Silverstein, SUNY Coll. Environ. Sci. and Forestry, Syracuse, NY 13210.

Field studies conducted in central New York tested the attractiveness of 2 compounds isolated from *Pissodes strobi* (Peck). Previous tests showed that *P. strobi*, the white pine weevil and *P. approximatus* Hopkins, the northern pine weevil, were cross-attractive to male-produced aggregating pheromones released from breeding sites appropriate for the respective species. The monoterpene alcohol, grandisol, and corresponding aldehyde were isolated by extraction of volatiles from live *P. strobi* and their crushed abdomina. In late summer of 1976, 30 sticky traps utilizing 6 different treatments captured 119 *Pissodes*. Low levels of grandisol and the aldehyde, released from separate plastic vials, were competitive to live male *P. approximatus* when both treatments contained red pine bolts. Attractiveness of grandisol and the aldehyde with red pine was significantly greater than these compounds without red pine. More intensive tests in 1977 captured 422 *Pissodes*, 340 of which were females. Results indicate that the concentration of the chemicals significantly influences the attractiveness, with a higher level of the compounds capturing nearly twice the number of the lower level. Neither the alcohol nor the aldehyde was highly attractive individually. We conclude that the 2 male-produced compounds and host volatiles act synergistically to attract both sexes of *P. approximatus*.

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Effect of Molting Disruptants on *Choristoneura fumiferana* (Clemens) (Lepidoptera: Tortricidae) Viability and Reproduction.—J. Brushwein and J. Granett, Univ. Maine, Orono, ME 04473.

Two insect growth regulators (IGRs) which disrupt molting, 50% WP EL-494 and 25% WP Dimilin® were tested in the laboratory against eastern spruce budworms. Field collected, newly molted, 6th instars were fed solely balsam fir foliage previously dipped in toxicant solutions of 400 ppm, 40 ppm, or 4 ppm, or 400 ppm carrier solution alone, and air-dried. Ten replicates of 10 insects each were used for each chemical and rate, and sufficient larvae were reared on untreated foliage for matings. Complete mortality occurred at the 400 and 40 ppm toxicant levels prior to adult emergence. The pupal $LD_{50}$ for Dimilin was close to 4 ppm. The pupal $LD_{50}$ was above 4 ppm for EL-494. However, EL-494 also caused high mortality in emerged adults. Matings between adults reared through on EL-494 and untreated individuals produced no viable eggs. Dimilin did not reduce reproduction of treated males mated with untreated females but did reduce reproduction of treated females mated with untreated males. Neither set of carrier-treated insects had reduced viability or reproduction. Both IGRs caused formation of morphological abnormalities in pupae similar to juvenile hormone analogue affected individuals. Abnormalities included presence on the pupae of larval prolegs, larval thoracic legs, larval head capsule, and malformed wing pads. In many individuals EL-494 caused adults to emerge incompletely from the pupal skin. These materials may have potential for spruce budworm control when applied during the 6th instar.

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Morphology and Taxonomy of Gall-like Scale Insects *Kermes* spp. (Homoptera: Kermesidae) in Eastern North America.—S. W. Bullington and M. Kosztarab, VPI and SU, Blacksburg, VA 24061.

Female scale insects of the genus *Kermes*, parasites of trees of the genus *Quercus*, are virtually unidentifiable to species. Most of the descriptions of the 10 eastern species are based on postreproductive females, whose body shape and color pattern are subject to great changes. They are also difficult to mount on slides. Keys have never been prepared. A revision of the group in North America has revealed that postreproductive females have highly vaulted venters separated from the substrate by anteriorly- and posteriorly projecting flaps. These flaps, or "pseudoventer," are species specific in shape, as is the architecture of the cavity enclosed by the true venter. Seven of the species appear to be synonyms; the remainder can be divided into 3 groups based on the pseudoventer: those with 2 anterior

and 2 posterior flaps (*K. pubescens*), those with a single, median anterior flap and 2 posterior flaps (*K. andrei* and one undescribed species), and those with a median, posterior flap as well as 2 anterior and 2 posterior lateral flaps (*K. galliformis* and one undescribed species). Within each group the species differ in the shape of the flaps, as well as in the extent the cavity they enclose is hollowed. Other distinctive characters are visible only on prereproductive adult females that have been slide-mounted. This correlation between slide-mounted, prereproductive and dry-preserved, postreproductive material will make it possible to swiftly and accurately identify the latter, the most commonly noticed stage.

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Alternate Methods of Cockroach Control: Other Approaches.—G. S. Burden, Insects Affecting Man Research Laboratory, ARS, USDA, Gainesville, FL 32604.

Present and potential alternatives for the reduction of cockroach infestations are usually less spectacular and sometimes less efficient than the methods of residual sprays, dusts, and aerosols that are the essential mainstays in control programs. However, some of the alternate methods have usefulness as sole approaches or in integrated control programs directed against assorted species of cockroaches, whereas other alternate methods are very limited or impractical in their usefulness. Insecticidal baits may be considered an alternate method of cockroach control because they are the least used of the chemical approaches. Baits offer the possibility of efficient insect control where other methods cannot be used, or in environments where they can be included with insecticidal sprays and/or dusts. Chemosterilants have been evaluated in the past and have been shown to function as sterilants to male and female cockroaches. However, the practical usefulness of chemosterilants is precluded by the long life cycle of the pestiferous cockroaches. Chemicals that function as repellents to cockroaches could be useful alone or in integrated control programs to prevent the aggregation, reinfestation, and transportation of cockroaches. Many factors inherent in the activity of parasites, pathogens, predators, pheromones, and hormones render these as potential but limited approaches for the control of the species of cockroaches that are of major importance in human environments. Exclusion and sanitation are preventive methods that should be the basic approaches to all principal and alternate methods used in control programs.

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Cytology of Urate Storage in *Periplaneta americana* (L.) (Dictyoptera: Blattidae).—D. G. Cochran, VPI and SU, Blacksburg, VA 24061.

Urate storage in the American cockroach has been well documented, and shown to occur primarily in the fat body. The level of urate storage is known to be influenced by the amount of nitrogenous material contained in the diet. Cytologically, the fat body consists of 3 types of cells: trophocytes, mycetocytes, and urate cells. Presumably, urates are stored only in urate cells, but the cytological implications of varying levels of urate storage, imposed dietarily, have not been investigated. In order to do so, tissue squashes, cryostat and epon sections of fat body from adult males have been studied with either the light or the transmission electron microscope. Dietary regimes consisted of dextrin, dog food, 24%, 42% and 66% casein protein. The results confirmed the presence of 3 cell types in fat body. Normally, urate cells lie near mycetocytes and neither are found close to the periphery of a fat body lobe. On a dextrin diet essentially no urates are present, but collapsed urate cells are detectable. As dietary nitrogen increases, urates can easily be detected because of their birefringence under polarized light. Urate cells become increasingly packed with urate crystals, and both urate cells and mycetocytes increase in numbers. At the higher dietary nitrogen levels, fat body is often overwhelmed with urate deposits. These findings provide a firm cytological basis for understanding how urate storage is accomplished in this insect.

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Resistance and Cross-resistance in Cockroaches (Orthoptera).—W. J. Collins, Ohio State Univ., Columbus, OH 43210.

Data on insecticide resistance in German cockroaches, *Blattella germanica*, are summarized from published reports. Although there are exceptions, the following generalities have emerged from resistance studies in this species: 1) DDT-resistant cockroaches are not resistant to insecticides in other major groups; 2) chlorinated cyclodiene and/or lindane resistance does not involve resistance to other groups; 3) diazinon resistance confers resistance to other organophosphates, including malathion, and may cause resistance to pyrethrins, DDT and propoxur; 4) malathion resistance may not involve resistance to other organophosphates; 5) propoxur resistance confers resistance to other carbamates and may include resistance to organophosphates, including malathion, pyrethrins and DDT. Resistance ratios will vary significantly, depending upon the method that is employed. The most common techniques are: topical application, dipping, direct spray and tarsal contact on glass, wood, masonite or paper. Knockdown and mortality are the most common response criteria. Male cockroaches are

generally less resistant than females. The inheritance of resistance has been studied most extensively in laboratory colonies. Resistance is generally a monofactorial trait that is not sex-linked. Resistance may be recessive (diazinon, propoxur), semidominant (aldrin, DDT, pyrethrins) or dominant (malathion). Chlordane resistance is apparently a fairly stable phenotype; reversion to susceptibility is slow when insecticide pressure is discontinued.

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Mortality of *Parasetigena silvestris* and *Blepharipa pretensis* (Diptera: Tachinidae) under Controlled Overwintering Conditions.—D. S. Dalton, Univ. Virginia, Charlottesville, VA 22903.

Overwintering mortality of 2 tachinid parasites of *Lymantria dispar*, *P. silvestris* and *B. pretensis*, was investigated under 5 artificial conditions as a part of a parasite establishment project. Two treatment groups were overwintered outdoors in Morristown, NJ where the insects were collected. In the first, parasites were put in soil-filled trays as maggots free to seek their depth and position with a minimum of handling and storage. The second was a tray filled with alternating layers of sifted soil and fly puparia. The majority of puparia were transported to Charlottesville, VA to be placed in 1 of 3 treatments. The first treatment was a layering of puparia and soil medium in a tray which was buried in woods surrounding the lab. The second involved the same layering but overwintered in a controlled temperature and humidity chamber. In the third treatment, also placed in the environmental chamber, the puparia were surface sterilized and placed in autoclaved soil. Samples of insects overwintering in Virginia were dissected in August and December to determine distribution of mortality during the overwintering period. Results of the study showed: 1) mortality was significantly lower in the NJ treatments which involved a minimum of handling and storage, 2) no differences in mortality between any of the 3 VA treatments in which survival was uniformly low, 3) mortality peaked following pupariation and preceding emergence, 4) parasites that began the experiment as maggots had significantly lower mortality than those that began as pupae and 5) sterilization of puparia and soil had no effect on survival.

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Status of the Red Pine Scale, *Matsucoccus resinosae* B. & G. (Homoptera: Margarodidae).—E. J. Duda, Univ. Connecticut, Storrs, CT 06268.

In the 31 years since it was first recorded, the red pine scale has become one of the most serious pests of red pine. It also attacks Japanese black, Japanese red, and Chinese pines. The scale is a killer that shows no preference for tree size. Although the areas of known infestation are restricted

to Connecticut, New York and New Jersey; the scale is a serious threat to planted and natural stands of red pine in the northeast and Lake States. Extensive studies have been conducted on control, but there is as yet no effective, practical means of achieving this end. Two generations of *M. resinosae* occur in a growing season, crawlers of the first appearing in June, those of the wintering brood in August and September. Mortality within a single generation normally is very high. It is determined by physical factors, predators and intraspecific competition. Highest mortality occurs in the neonate crawler stage. Low temperatures could play a role in restricting northward spread. Biological control factors appear to be limited to the work of predators of which an anthocorid bug, *Xenotracheliella inimica* D. & H. is the most effective. Life tables demonstrate the existence of 3 periods when the scale population is drastically reduced. These are the period from egg to sessile form of 1st-stage larva of summer and winter generations, and during the sessile form of over-wintering generation.

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The Control of Apple Insect Pests in New Hampshire 1974–1977.—G. T. Fisher, Univ. New Hampshire, Durham, NH 03824.

During the 3-season period 1974–1976, replicated and randomized efficacy trials were conducted in a mature, experimental 10-acre apple orchard in Durham, NH. Varieties within the orchard were standard Red Delicious, McIntosh and Cortland. Materials were applied as a (1×) spray averaging 300 gal/acre at 300 psi to the run-off of both leaves and fruit. Treatments were replicated 3–4 times and randomized as single tree replications. Applications were made at ½ inch green, pink, bloom (fungicide only), petal fall, and 6 cover applications. Fruit (100/replicate) at harvest were examined for damage from the following insects: the tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois); the red-banded leafroller, *Argyrotaenia velutinana* (Walker); the codling moth, *Laspeyresia pomonella* L.; the plum curculio, *Conotrachelus nenuphar* (Herbst); the apple maggot, *Rhagoletis pomonella* (Walsh). Materials used in these experiments were: Furadan (carbofuran); ICI PP556 (NRDC 104); Phosvil (leptophos); Carzol (formetanate); Dimilin (TH-6040); Lannate (methomyl): CGA 18809; Mobil 9087; Zolone (phosolone); Imidan (prolate); Guthion (azinphos-methyl). Recommended experimental rates were suggested by the manufacturer. Zolone, Furadan ICI PP557 (4 fl. oz.), Phosvil, Carzol and Lannate give excellent control of plum curculio, apple maggot, codling moth and red-banded leafroller, however, only Mobil 9087 gave economic control of the tarnished plant bug. Fair control of the plum curculio shown by Imidan and Guthion was due to an irregular season (1976) with abnormally high population in plots (check showed 257.3 stings/100 fruit).

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The Control of Adult Black Flies (Diptera: Simuliidae) with ULV Ground Apparatus in New Hampshire.—G. T. Fisher and J. W. Martin, New Hampshire Exp. Sta., Durham, NH 03824.

Over a 3-year period, 7 insecticides were tested for efficacy on adult black flies, *Simulium venustum* Say, *S. tuberosum* Lundstrom, and the *Prosimulium mixtum* Peterson complex, in the White Mountains of New Hampshire. The control of these insects is especially vital to tourist trade, and the use of adulticides provides limited control for short periods of time. Malathion 57% EL, Dibrom 8 and 14, Baygon 70% WP and 1 MOS, Sumithion ULV and Pydrin 8 EC were applied at the manufacturer's recommended rates in the towns of Waterville Valley and Dixville Notch, NH. Plots consisted of open, wooded and residential areas. Adult black fly populations were sampled before treatment and at 30 min, 1, 4, 8, 24, 48 and 72 h after treatment. Malathion 57% EL, unlike the other formulations, showed no efficacy. The ultra low volume formulations, when applied through a BEECO-mist nozzle fitted on a John Bean Mist Blower, showed both efficacy and ease of application. Dibrom 14 gave 100% control within 4 h, but showed no appreciable residual quality; Baygon 1 MOS showed better residual quality with lesser knockdown; Sumithion ULV gave excellent control and Pydrin 8 EC, tested only in 1977, showed potential efficacy. This method of control is suitable in small areas where aerial pesticide application is restricted.

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Chemical and Physical Factors Affecting the Feeding of Female *Culiseta inornata* (Williston) (Diptera: Culicidae).—W. G. Friend, Univ. Toronto, Toronto, Ontario, Canada M5S 1A1.

The feeding responses of mosquitoes are complex. Both males and females drink water and feed on nectar, females also feed on blood. Blood usually goes to the mid-gut, sugar solutions to the crop. It is generally believed that the destination of the meal is directed by chemicals in the diet and is independent of the mode of feeding. Recent work with *C. inornata* in our laboratory has shown that the mode of feeding can significantly affect the responses to ATP, the phagostimulant found in blood that induces most haematophagous insects to gorge. If females are presented the artificial diet containing ATP as a free liquid at room temperature, they accept it as they would water, taking between 0.01 and 1.33 $\mu$l and directing it to the mid-gut. If the same diet is presented under a silverlight membrane at blood temperature the females take 1.02 to 3.68 $\mu$l into the mid-gut. By manipulating the relative amounts of ATP and sucrose in the artificial diet changes in the threshold of response to these phagostimulants can be demonstrated as the mode of feeding is changed.

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*Compsilura concinnata* (Meigen) (Diptera: Tachinidae): Longevity, Development, and Production of Progeny on the Gypsy Moth.—R. A. Fusco, Pennsylvania Dept. Environ. Resources, Middletown, PA 17057.

The effect of several constant temperatures on the ability of *C. concinnata* to increase in numbers was studied in the laboratory for maximizing production in a mass-rearing program. Successful development from 1st-stage larva to adult occurred within a temperature range of 15.6–29.4°C. At 32.2°C, the highest temperature tested, adult flies failed to emerge. Percent parasitism and adult emergence were greatest between 15.6 and 23.9°C. Mean number of puparia/host was highest in larvae exposed between 18.3 and 26.7°C. Both larval and pupal development time varied inversely with temperature within the range of 15.6–26.7°C. Longevity and duration of both prelarviposition and larviposition were inversely related to temperature. Production of puparia by individual females was highly variable. Males were capable of multiple mating, and effectively fertilized as many as 6♀. The results of these tests indicate that an ideal rearing program would incorporate the following environmental regime, tailored for optimum yield of specific parasite life stages: 1) 21.1°C for high adult activity periods (mating and parasitizing); 2) 26.7°C for larva and pupa developmental periods (pre- and postlarviposition and preemergence adult development); and 15.6°C for storage of adult flies overnight or between periods of host exposure and larviposition. Parasite progeny may be stockpiled in the pupal stage for 2–4 weeks at 10–15.6°C, or as developing maggots in host larvae at 10–15.6°C for up to 2 weeks.

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Trail Following Behavior in the Gypsy Moth Caterpillar *Porthetria dispar* (L.) (Lepidoptera: Lymantriidae).—E. M. Gallagher and G. N. Lanier, SUNY, Syracuse, NY 13210.

Gypsy moth larvae were observed in a light infestation on red and white oaks in Clay, NY, to examine the role of silk trails in larval movements. On an area of a tree that was observed to have silk on it, two 8 × 16.5 cm sections were marked off. The silk was removed from one section by brushing vigorously with a stiff, plastic-bristled brush, while the other section served as a control. The response of larvae to the treatment area was generally a marked hesistancy or refusal to cross, while larvae readily crossed the control area in all trials. To examine the involvement of trail following chemicals in gypsy moth silk, 2 additional areas were marked off. Hexanes were used to extract the silk in one area by dripping it down the tree trunk from the top and collecting it at the lower border of the section. The second area was a control. Larval response to the extracted area was similar to

responses to a desilked area. Most hesitate or refuse to cross the treatment section, while few respond in that manner to the control. These results indicate that gypsy moth larvae may be using a trail system to relocate established resting and/or feeding sites, and that the nature of these trails may be chemical, similar to those reported for other Lepidoptera larvae. They further form the basis for continuing investigations into the nature and chemistry of a gypsy moth trail system.

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*Musca autumnalis* (DeGeer) (Diptera: Muscidae) as vector of *Thelazia* sp. (Bosc) (Nematoda: Filaroidea) in Massachusetts.—C. J. Geden and J. G. Stoffolano, Univ. Massachusetts, Amherst, MA 01003.

The genus *Thelazia* includes several species of parasitic eyeworms of cattle and horses. *T. gulosa* and *T. skrjabini* have been recovered from the eyes of cattle in Kentucky and Massachusetts while *T. lacrymalis* has been found in horses in Maryland, Kentucky and Ontario. Adult worms generally live in lachrimal ducts of mammals where they deposit 1st-stage larvae into the eye secretions ingested by feeding face flies. The worms penetrate the gut and become surrounded by a capsule in the abdomen of the fly where they develop into invasive-stage larvae. The larvae rupture the capsules, migrate to the head and exit through the proboscis into the eye of a new host. To determine the incidence of parasitism in the flies eighteen collections of female face flies were made from cattle throughout Massachusetts and inspected for *Thelazia* larvae. An average infection rate of 2.6% was found ranging from 0.5–13.2%. The number of worms/fly ranged from 1–30 with an average of 3.2. Of 361 capsules found in the abdomens, 75% were attached to cuticle, 23% to fat body and 2% to Malphigian tubules. Our findings thus suggest that bovine thelaziasis is fairly widespread throughout Massachusetts.

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Tsetse Flies *Glossina morsitans* West. (Diptera: Muscidae): Research with African Sleeping Sickness.—J. B. Gingrich, G. H. Campbell, A. B. Bosworth, R. N. Wilkinson and R. A. Ward, Walter Reed Army Inst. of Res., Washington, DC 20012.

Attempted establishment of a self-sufficient colony of tsetse flies for trypanosomiasis studies has shown guinea pigs to be unsuitable hosts since puparial weights decreased steadily from 27.4 mg for the parental (Bristol) flies to 23.8 mg for the $F_2$ generation while percent emergence concurrently dropped from 95% (parental) to 65% ($F_2$). Feeding flies on rabbits has significantly improved these measures of colony vigor. Preliminary obser-

vations on flies infected with cloned stabilates of *Trypanosoma rhodesiense* (isolated from a Kenyan in 1975) suggests that some stabilates that have been syringe-passed 10 or more times will not yield mature fly infections, probably due to the midgut establishment barrier. Some success was obtained by growing insect stages of parasites in a tsetse fly-derived cell line, and both primary cultures and several continuous cell lines are being screened for development of the blood stages of trypanosomes. A clone of trypanosomes obtained from the original isolate produced a chronic infection in C57 mice from which 13 serologically distinct variant clones were obtained.

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Chemical Control of Resistant Cockroaches.—J. M. Grayson, VPI and SU, Blacksburg, VA 24061.

Efficacious chemicals for controlling normal and resistant cockroaches are reviewed in 6 categories: 1) Residual applications, oil or water extended, from such standard materials as diazinon, propoxur, chlorpyrifos and malathion; and from promising newer chemicals such as bendiocarb, acephate, fenitrothion and others; 2) Slow release residual treatments such as dichlorvos in resins or plastics, encapsulated SBP-1382, encapsulated diazinon, encapsulated fenitrothion and multilayer tapes containing diazinon, propoxur or chlorpyrifos; 3) Dust applications of diazinon, malathion, sodium fluoride, boric acid powder, silica aerogels and pyrethrum plus sulfoxide; 4) Baits of different composition with such toxic ingredients as dichlorvos, propoxur, boric acid, trichlorfon and chlordecone; 5) Knockdown and/or flushing agents, e.g., pyrethrum (either alone or in combination with synergist), dichlorvos and SBP-1382; 6) Synthetic and botanical extracts effective as repellents, e.g., MGK R-874, MGK R-11 and a number of N,N-disubstituted n-aliphatic amides.

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Effect of Artificially Administered Steroids, Blocking Agents, and Social Stress in Chickens on Northern Fowl Mite Population Development (Acarina: Macronyssidae).—R. D. Hall and E. C. Turner, Jr., VPI and SU, Blacksburg, VA 24061.

Corticosterone administered intravenously or orally to white Leghorn roosters was shown to inhibit northern fowl mite population development. In roosters genetically selected for a low plasma corticosterone response to social stress, metyrapone and desoxycorticosterone administration increased mite population development over that on control birds. The dosage of orally administered corticosterone required for maximum inhibition of

mite population development in most inbred Leghorn lines tested was between 20 and 30 ppm. Dosages higher or lower than this range often increased the severity of mite infestation. Roosters subjected to extremes of social interaction displayed differences in mite resistance. High levels of social stress resulted in reduced mite population development, while birds housed alone suffered large mite populations within a short time. Post mortem examination revealed that roosters made mite-resistant by steroid administration or high levels of social stress produced poorer weight gains and testes development than mite-susceptible birds in low-stress environments and on non-steroid feed. Initial tests showed that the mechanism of mite resistance in those cases tested resulted from decreased capillary density in the skin proximate to the birds' vents.

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Tabanidae of the East Coast as an Economic Problem.—E. J. Hansens, Rutgers University, New Brunswick, NJ 08903.

Tabanidae are pests of man and animals in many areas of the coastal states but especially near salt marshes. The major species, *Tabanus nigrovittatus* and *Chrysops atlanticus*, move from the marshes to nearby beaches, camp grounds, golf courses, and other recreational areas and onto boats in the bays and estuaries. *Chrysops* congregate in dense vegetation and attack when man or animals move into such places. Both *Tabanus* and *Chrysops* are severe problems to agricultural workers when the flies are numerous. Biology and habits of both salt marsh and upland species are poorly known. The problems are further complicated by the probability that *T. nigrovittatus* is a complex of closely related species. The member of the complex in more northern areas is a much more avid feeder on man. Livestock are readily attacked by Tabanidae with consequent effects of thriftiness, weight gains and milk production. Some species transmit causal agents of disease to domestic animals and wildlife. Controls are inadequate though box or canopy traps and vegetative barriers have been shown useful against *Tabanus* and some insecticides have given reduction but not adequate control of both *Tabanus* and *Chrysops*. Livestock cannot now be protected adequately from attacks of Tabanidae.

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Observations on Field Behavior of Plum Curculio Adults, *Conotrachelus nenuphar* (Coleoptera: Curculionidae).—K. I. Hauschild, E. D. Owens and R. J. Prokopy, Univ. Massachusetts, Amherst, MA 01003.

The plum curculio is one of the 5 major pests of apple fruit in New England. Although its general biology has been described by several

authors, the behavior of adults is not well known. Our goal is to attain sufficient understanding of adult behavior so that we can develop an effective device for monitoring adult population levels. Within 3 weeks of petal fall, and from dawn to until ca. 1 h after dusk, we observed 47 h of adult curculio behavior on unsprayed apple trees in Masschusetts. The adults spent the majority of their active time crawling on branches, twigs, leaves, and fruits apparently in search of food or ovipositional sites. However, resting in protected places, such as twig crotches and the calyx end of the fruit, was the most frequently observed behavior. Only 5 of the 70 curculios observed flew. Fruits were located apparently via tactile stimuli, with distribution of oviposition scars among fruits and branches of sampled trees being random rather than uniform. Overall, our findings show that compared with the within-tree activities of apple maggot, European apple sawfly, and tarnished plant bug, plum curculios fly much less frequently and are much less visually oriented. Therefore, sticky-coated visual traps are of dubious potential value for monitoring adult curculio populations. In addition, continuous monitoring with funnel traps on the ground beneath infested trees indicated little dropping of curculios from the canopy during calm weather, though some dropping during windy periods. Funnel traps are therefore also of doubtful value for accurate monitoring.

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Evaluation of *Akis bacarozzo* Schrank (Coleoptera: Tenebrionidae) as a Predator of Eggs of the Gypsy Moth, *Lymantria dispar* (L.) (Lepidoptera: Lymantriidae).—R. C. Hedlund, Benefical Insects Research Laboratory, USDA, ARS, Newark, DE 19713 and J. S. Russin, Univ. Delaware, Newark, DE 19711.

*Akis bacarozzo* was reported by USDA, ARS cooperators in Morocco to be a predator on eggs of the gypsy moth. In June 1975, 148 adults of this beetle were collected and sent to the ARS quarantine laboratory in Newark, DE, for evaluation. Identification of the species was determined by T. J. Spilman of the USDA Systematic Entomology Laboratory. The adult beetles were long-lived, surviving for more than 2 years in the laboratory. Mating was common and up to several hundred eggs were collected weekly. The eggs hatched in 13 days at 21°C. Both larvae and adults fed readily on semi-moist dog food although no larvae were reared to pupation. Both larvae and adults were supplied with gypsy moth eggs as food. The larvae ate only de-haired eggs and only when there was no other food available. The adult beetles fed on gypsy moth eggs only when starved for periods of 11–30 days. In some instances the adults died without feeding. The adults fed readily on rolled oats, white rice, buckwheat, cut oats, rye, corn,

soybeans, hardwheat and soft wheat. Neither the adults nor the larvae of this predator attacked live gypsy moth larvae although the adults were observed to feed slightly on dead gypsy moth larvae. From these tests it was concluded that *Akis bacarozzo* had little or no potential as a predator on gypsy moth eggs.

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Mineral requirements for brood rearing by *Apis mellifera* L. (Hymenoptera: Apidae) fed a synthetic diet.—E. W. Herbert, Jr. and H. Shimanuki, USDA, Agricultural Research Service, Beltsville, MD 20705.

The mineral requirements of honeybees have been neglected in nutritional studies. Additional research is essential since Wesson's salts and other salt mixtures designed for vertebrates have proved ineffective in honeybee diets. Since pollen constitutes the predominant source of minerals for honeybees, atomic absorption techniques were used in chemical analyses of pollen ash for the following elements: potassium, sodium, calcium, magnesium, zinc, mangenese, iron and copper. Also, the optimum level of ash for brood rearing was determined by feeding honeybees five levels in a chemically defined diet containing 18 amino acids and 10 water soluble vitamins. In this study, each diet was offered to nuclei containing newly emerged bees and a mated queen held in a screen flight cage. The production of sealed brood and diet consumption were measured weekly. Bees fed a synthetic diet fortified with 1% pollen ash supported the greatest quantity of brood followed, in descending order, by bees fed diets fortified with 0.5, 2.0, 4.0, 0.0 and 8.0% ash. Bees were able to rear brood when fed an ash-free diet, but the addition of pollen ash resulted in improved brood rearing. Bees fed the diets containing the higher ash levels (4.0 and 8.0%) had high initial mortality, and the larval and adult populations began to dwindle early. This suggests that the ash content of pollen (mean 3.17%) may not be optimum for maximum colony development.

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Sex Pheromone of the Black Cutworm Moth, *Agrotis ipsilon* (Hufnagel) (Lepidoptera: Noctuidae).—A. S. Hill and W. L. Roelofs, NYS Agr. Expt. Sta., Geneva, NY 14456, and R. W. Rings and S. R. Swier, Ohio Agr. Res. Develop. Center, Wooster, OH 44691.

The black cutworm is a widely distributed agricultural pest for which the availability of a specific attractant could be very useful. We have identified (Z)-7-dodecenyl acetate (I) and (Z)-9-tetradecenyl acetate (II) as components of its sex pheromone. These compounds are emmitted by the female and, in combination, they attract the male moths. They were iden-

tified by their adsorption (liquid) chromatographic and gas chromatographic (GC) properties, mass spectral patterns, and chemical reactions (alkaline hydrolysis and reacetylation; ozonolysis products). Crude and treated female abdominal tip extracts were assayed by 2 methods: electroantennographic and wind tunnel (flight chamber) bioassays. Electroantennograms revealed only the presence of I. In a wind tunnel, both components were required to elicit upwind flight, through the chemical plume and terminating at the chemical source, by the male moths. Some upwind anemotaxis was seen with I alone, but it was not sustained and did not result in arrival of the insect at the chemical source; none was seen with II alone. Various combinations of I and II on rubber septa (1:1 and 3:1, 3 $\mu$g to 100 $\mu$g of each) or dispensed from capillary tubes sealed at one end (1:1 to 10:1, 1–4 capillary tubes) are effective lures in the field; neither I nor II alone is effective. Small amounts (1% or less) of the corresponding (*E*)-isomers appear to have no effect on trap catches.

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Influence of Pesticides on Predacious and Phytophagous Mite Populations in Massachusetts Apple Orchards.—R. G. Hislop, C. Acker, and R. J. Prokopy, Univ. Massachusetts, Amherst, MA 01003.

The population dynamics of several species of phytophagous and predacious mites were determined in 1976 in 5 commercial and 3 abandoned apple orchards. A phytoseiid, *Amblyseius fallacis* (Garman), and a stigmaeid, toseiid, *Zetzellia mali* (Ewing), accounted for the majority of predators in orchards using spray programs with different combinations of Guthion, Imidan, Captan and Cyprex. European red mite, *Panonychus ulmi* (Koch), and apple rust mite, *Aculus schlectendali* (Nal.) were the dominant phytophagous species. Mite predator populations were extremely low in orchards using Zolone, Glyodin, and Benlate in different combinations with the previous materials. Two-spotted mite, *Tetranychus urticae* Koch, appeared in moderate to high numbers whereas rust mite and red mite were relatively low in abundance. More miticide applications were necessary in orchards using the latter materials. In orchards abandoned at least 8 yr two-spotted mite was not found and European red mite was relatively scarce. Phytoseiid mites, particularly *Typhlodromus pomi* (Parrot), and *Phytoseius macropilus* Banks, were found in moderate to high numbers. Laboratory toxicity studies on adult females of pesticides at normal field concentrations (using the slide dip method) indicate Zolone and Glyodin are highly and moderately toxic to *A. fallacis* and of low toxicity to *T. urticae*. Guthion, Imidan, Captan and Cyprex were of low toxicity to both species. This suggests that *A. fallacis* cannot survive where Zolone and Glyodin are used, thereby allowing buildup of two-spotted mite.

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Scanning Electron Microscope Studies of Haller's Organ for Systematic Purposes in the Tick Genus *Ixodes* Latreille (Acari: Ixodidae).—P. J. Homsher and D. E. Sonenshine, Old Dominion Univ., Norfolk, VA 23508.

Scanning electron microscopy provides an excellent tool for studying the undistorted form of external surface features in more detail and with more accuracy. In turn, the biosystematist can identify subtle differences in important taxonomic characters that are not possible to analyze by other microscopic means. Ten characters are identified that show distinct differences among the species examined. These are (1) shape of entire organ, (2) shape of anterior trough, (3) height of anterior trough walls, (4) presence or absence of distal transverse wall of anterior trough, (5) location of anterior trough sensilla, (6) shape of posterior capsule aperture, (7) area of posterior capsule aperture, (8) number of tarsal hump setae, (9) location of tarsal hump setae and (10) size of tarsal hump setae. These characters have been applied to Haller's organs of representatives of 15 species of *Ixodes*, some of which are very similar in gross morphology (e.g., *Ixodes brunneus* and *Ixodes frontalis*). Discontinuous variation has been observed between well defined species as well as between those with similar morphology. Use of SEM for systematic purposes must be in conjunction with other analyses of the taxonomic relationships in the genus. However, it appears that the differences identified in Haller's organ by use of the SEM corroborate the relationships proposed using other characteristics and are definable at a level equal to them when used to establish species limits.

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Biological Control and Lifestyles of Parasitic Hymenoptera.—D. J. Horn, Ohio State Univ., Columbus, OH 43210.

Does introduction of several parasite species result in more effective biological control than introduction of a single "best" species? I compared reproductive biologies of parasitic Hymenoptera associated with the alfalfa weevil (*Hypera postica* (Gyllenhal) (Coleoptera: Curculionidae)), cereal leaf beetle (*Oulema melanopa* (L.) (Coleoptera: Chrysomelidae)), bagworm (*Thyridopteryx ephemeraeformis* Haworth (Lepidoptera: Psychidae)) and California oakworm (*Phryganidia californica* Packard (Lepidoptera: Dioptidae)). Lifestyles of these parasites tended toward one of 2 extremes: 1) high fecundity, short handling time, larger size, monophagy, rapid dispersal ("r-strategist" or "dumper"), and 2) low fecundity, long handling time, smaller size, polyphagy, slower dispersal ("K-strategist" or "plodder"). These parameters are easily measurable in field and laboratory. Computer simulations based on these observations show that a "dumper" will be established more quickly, and can reduce host numbers from high densities, whereas a

"plodder" is more likely to contain the host at low densities. Effective biological control therefore results from importation of parasitic wasps representing both extremes, i.e. a multispecies complex rather than a single "best" species. Initial consideration should be given to "dumpers" whose attack rates exceed oviposition and/or growth rates of their host.

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Beech Bark Disease (*Cryptococcus fagi* Baer. (Homoptera, Coccidae, Ericoccidae) and *Nectria* spp.)—Status in Europe and United States.—D. R. Houston, USDA, Forest Service, Hamden, CT 06514.

Beech bark disease (BBD) results when heavy attacks by *C. fagi* predispose beech trees to *Nectria coccinea* (Europe) and *N. coccinea* var. *faginata* (North America). *C. fagi* and BBD are widespread in Europe with damage currently heavy in young plantations in southern England and older ones in western France; and increasing in plantations of southern Germany. In England, scale buildup on young trees is favored by heavy protective coatings of the bark lichen, *Lecanora conizaeoides*. On some trees, the bark fungus, *Dichaena rugosa*, appears to restrict *C. fagi*. As the scale, introduced to Nova Scotia in 1890, spread through Maine, New Hampshire and Vermont, heavy tree mortality occurred. The complex is causing serious losses in eastern New York and Pennsylvania. In long-affected forests of New England, another scale, *Xylococculus betulae*, causes severe defects that provide spatial niches for *C. fagi*, often on trees too small to be generally susceptible. Evidence suggests that BBD will once again cause serious problems in areas hard hit several decades ago.

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INKTO: The National Reference Collection of Insect Pests not Known to Occur in the United States.—P. A. Kessler and L. Knutson, Insect and Beneficial Insect Introduction Institute, USDA, ARS, Beltsville, MD 20705.

A collection of insect pests not known to occur in the United States is maintained and distributed by the Insect Identification and Beneficial Insect Introduction Institute (IIBIII). The collection at present includes 59 foreign pests, most of which have been described in the Cooperative Plant Pest Report, or its predecessor, the Cooperative Economic Insect Report, published by the Animal and Plant Health Inspection Service, USDA. The IIBIII attempts to obtain 100 specimens of each species from cooperators and foreign explorations throughout the world. Specimens are authoritatively determined by research taxonomists of the Systematic Entomology Labratory (SEL), IIBIII, and the Smithsonian Institution before being sent to 63 federal and state locations, including 18 APHIS ports of

entry. The purpose of the collections is to facilitate immediate recognition of a foreign pest in an effort to prevent its establishment in the U.S. Collections placed in ports of entry are a reference for APHIS port identifiers who intercept approximately 7,000 species of exotic insects and mites per year. Those not identifiable by a port inspector are rushed to SEL for identification. An average of 1,500 port interceptions not recognizable by port identifiers are sent to SEL each year for "Urgent" determinations while merchandise or cargo is detained pending official determination. Collections placed with state and federal offices will hopefully aid in the detection of new infestations of pests that may be collected through routine surveys, light traps, etc.

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Techniques for Associating Developmental Stages of Ceratopogonidae and Other Diptera.—W. I. Knausenberger and E. C. Turner, Jr., VPI and SU, Blacksburg, VA 24061.

We have emphasized 2 main approaches: 1) Indirect association. The most successful technique involved dividing a sample into equal subsamples, extracting the larvae live (for subsequent rearing) from one subsample, and holding the other for adult emergence in uncomplicated but effective rearing cartons. The substrate could be aerated when necessary. 2) Direct association of larval and pupal exuviae for rearing individual larvae. Its main features include use of: a) small covered culture dishes ($35 \times 10$ mm and $60 \times 15$ mm), b) a substrate of non-nutrient agar, solidified at a slant. Batches of agar were prepared with different degrees of firmness (5–10 g agar/1,000 ml dist. water). Smaller larvae did best on softer agar, c) A selection of live food sources, primarily nematodes (*Panagrellus redivivus*) and small amounts of an infusion containing bacteria, algae, protozoa, rotifers, and microcrustacea. Larvae thus were able to seek their preferred food and moisture level within the given limits. Fungal contamination was very rare. Over 40 species of Ceratopogonidae in 12 genera were successfully reared. Development often was successful in over 50% of the attempts, compared with 15% before this technique. Best success was achieved with third and fourth instar larvae. To date, the longest period from initiation of rearing to successful emergence was 8 months. Representatives of Diptera in 10 other families have been reared from larvae by the agar technique, and 20 families by the recovery cartons. Chironomidae and Tipulidae predominated.

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Initial Establishment of *Ceuthorrhynchidius horridus* (Panzer) (Coleoptera: Curculionidae) on Thistles in Virginia.—L. T. Kok and J. T. Trumble, VPI and SU, Blacksburg, VA 24061.

*Ceuthorrhynchidius horridus*, a thistle rosette weevil, was first imported under quarantine from Italy for host specificity tests in 1970. After intensive testing, it was found to be sufficiently host specific and was officially approved for field release in Virginia in 1974. Between 1974–1976, 9 releases at selected sites spread over 5 counties were made: 4 were on *Carduus nutans* L. (musk thistle) and 5 were on *Carduus acanthoides* L. (plumeless thistle). The first release consisted of 30 adults and 2,000 first instars on musk thistle in Montgomery County in October 1974. The adults were placed among a dense patch of rosettes and the larvae were inoculated into the growth points (punctured by forceps) with a fine camel hairbrush. Seven releases of 100 adults each were made in November 1975. Three were on musk thistle (1 in Montgomery Co. and 2 in Pulaski Co.) and 4 were on plumeless thistle (2 in Giles Co., 1 in Warren Co., 1 in Russell Co.). In June 1976, a subsequent release of 200 adults each was repeated in two of the latter sites and an initial release of 160 adults was made on the fifth plumeless thistle site (Warren Co.). Detection surveys conducted annually in March and April showed initial establishment in all except the last site by the spring of 1977. Larvae were found in the meristematic tissues of plants on all 4 musk thistle sites and 4 of the 5 plumeless thistle sites. This is the first report of establishment of *C. horridus* in the U.S.A.

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Status of Scale Insects of Forest Trees—An Overview (Homoptera: Coccoidea).—Michael Kosztarab, VPI and SU, Blacksburg, VA 24061.

Losses caused by scale insects in the United States are estimated at $500 million yearly, but we will have to confirm such estimates with more detailed and accurate records in the future. Many species build up high population densities and reach economically important levels only after the trees are predisposed due to physiological stresses, e.g. drought. Individuals of some tree species manifest variation in resistance to scale insect infestation, e.g. juniper scale. Biologies, host preferences, distribution, economic importance, as well as recognition in the field and when mounted on microscope slides, are given for the following scale insect species from the Eastern United States not discussed by other participants of the workshop "Status of Scale Insects on Forest Trees": *Asterolecanium minus* Lindinger on oaks; *Carulaspis juniperi* (Bouché) on junipers and arborvitae; *Chionaspis heterophyllae* Cooley and

*C. pinifoliae* (Fitch) on pines; *Kermes galliformis* Riley and *K. pubescens* Bogue on oaks; *Pulvinaria acericola* (Walsh & Riley) and *P. inumerabilis* (Rathvon) on maples and other trees; *Toumeyella liriodendri* (Gmelin) on tulip trees and magnolias. All the above listed species have one generation per year in Eastern United States, except *T. liriodendri* with two generations in the southernmost parts of its range, also two generations in *C. heterophyllae* and *C. pinifoliae*.

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Determination of the Toxicities of Pirimor, Carbaryl and Monitor to *Coleomegilla maculata lengi* and *Chrysopa occulata*.—S. H. Lecrone and Z. Smilowitz, The Pennsylvania State Univ., University Park, PA 16802.

Knowledge of the effects of insecticides on predaceous insects is part of the complex of information needed to make an informed choice of insecticides in an integrated pest management program requiring insecticide intervention. The dose-mortality response is a means of evaluating the effects of insecticides on insects. Microsyringes were used to topically apply 1 $\mu$l volumes of the toxicants in acetone to lab-reared *Coleomegilla maculata lengi* (Timb.) (Coleoptera: Coccinellidae) adults and *Chrysopa occulata* (Say) (Neuroptera: Chrysopidae) 2nd instar larvae. Mortality was determined 24 and 48 h after treatment. The median lethal dose ($LD_{50}$) for each insect was determined by probit analysis. Between 330 and 450 insects were used to establish these values. The $LD_{50}$ values ($\mu$g/insect), 95% confidence limits and slopes of the dosage-mortality curves of the insecticides applied to *Coleomegilla maculata* were carbaryl, .063, .054–.070, 2.85; Monitor, .055, .048–.061, 3.21; Pirimor, 26.351, 24.017–29.741, 3.63. Insecticide responses to *Chrysopa occulata* were carbaryl, .090, .070–.109, 2.27; Monitor, .022, .019–.026, 2.30; Pirimor, 4.441, 3.203–6.253, 1.02. Pirimor was 49- and 202-fold less toxic than carbaryl and Monitor to *Chrysopa occulata* larvae and 418- and 479-fold less toxic to *Coleomegilla maculata* adults than carbaryl and Monitor. Carbaryl was 4-fold less toxic than Monitor to *Crysopa occulata* larvae, but approximately as toxic as Monitor to *Coleomegilla maculata* adults.

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Performance of Newly Available Acaricides Against the European Red Mite, *Panonychus ulmi* (Koch) [Acarina: Tetranychidae].—S. E. Lienk, Entomol. Dept., NYS Agr. Exp. Sta., Geneva, NY 14456.

Extensive field screening programs evaluating currently recommended and candidate acaricides were conducted in 1976–77 on apple. Two types of evaluations, namely preventive and eradicative programs were in-

vestigated. Emphasis was placed on early season or preventive type programs in which treatments were applied in the immediate pre-bloom period and directed against the overwintering eggs or newly hatched forms. The bulk of these treatments were applied with an airblast sprayer to unreplicated acre size plots. Population counts were made weekly by collecting leaves and brushing them with a Henderson-McBurnie machine. Eradicative tests were made in mid-summer against established red mite populations. In these trials records were taken directly in the orchard using binocular microscopes. A minimum of three observers counted all mite stages on independently selected subsamples of leaves. Of the pre-bloom treatments, petroleum oil, Plictran and BAAM in most instances gave seasonal control. A seasonal program in which 1 qt oil + 2 oz Benlate was included in every spray application also gave excellent control. Of 4 registered acaricides screened at low rates in three post-bloom sprays only Vendex gave satisfactory control. Candidates DPX 3792 and PP 199, a new diphenylamine acaricidae of 14 products applied against summer populations exhibited the highest control efficiency.

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Foraging Behavior and Colony Drift in *Vespula maculifrons* (Buysson) (Hymenoptera: Vespidae).—W. D. Lord, D. A. Nicolson and R. R. Roth, Univ. Delaware, Newark, DE 19711.

Eastern yellowjacket, *Vespula maculifrons*, is a common subterranean nesting species in the mid-Atlantic states. We studied its foraging behavior over a 2-year period in northern Delaware and Maryland. The wasps were predaceous on a diverse group of immature and adult insects and scavengers on fruits, honeydew, vertebrate carrion, and human foods. Marking studies in a 14-ha woodland demonstrated a maximum foraging distance of 275 m from nesting sites. The scavenging habits and foraging distances observed support *V. maculifrons*' inclusion in the *V. vulgaris* (L.) species group. Tagging experiments suggest at least a 1–2% exchange of foraging workers among nests within overlapping foraging ranges. Colony drift is unreported in Nearctic *Vespula*. Existence of colony drift in *V. maculifrons* suggests several questions for future study; 1. Is colony drift indicative of a poorly developed homing ability in *Vespula*? 2. Is there a functional colony-specific pheromone? 3. Are colonies in isolated woodland areas closely related genetically because of their isolation? 4. Is selection for adaptations to maintain colony integrity weak because of the genetic relatedness of these colonies? 5. Is colony drift related to the food resource base of the habitat?

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Survey and Population Assessment of the Spiders (Araneae) in an Abandoned, Unsprayed Apple Orchard in Central Virginia.—J. P. McCaffrey and R. L. Horsburgh, Shenandoah Valley Res. Sta., VPI and SU, Steeles Tavern, VA 24764.

Spiders are conspicuous members of the predator complex in Virginia apple orchards. Before a meaningful assessment of their importance as natural control agents of orchard pests can be made the species and populations that are present throughout the season must be determined. Weekly samples consisting of the spiders jarred from the lower branches of ¼ a tree for 4 trees forming a square were taken in an abandoned, unsprayed orchard in central Virginia during June–November 1976 and March–June 1977. A total of 1,117 spiders representing 11 families were collected and approximately 31 genera and 48 species were identified. The Thomisidae, Salticidae, Theridiidae, Anyphaenidae and Dictynidae composed 34, 27, 15, 7 and 7% respectively for a total of 90% of the total spiders collected. Spring and summer peaks of abundance were observed with a mean of 29 spiders per sample in May and 81 in August. Of the 324 spiders collected in August, 42% were thomisids of which 89% were immatures of *Philodromus* sp. In May 39% of the 114 spiders were salticids of which 50% were adults and subadults of *Metaphidippus* sp. (probably *galathea* (Walck)). This study indicates that although a large number of species may be present in the orchard ecosystem, relatively few will predominate and be influential in reducing or regulating orchard pest populations.

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Ecology and Control of *Fiorinia externa* Ferris (Homoptera: Diaspididae) on Eastern Hemlock.—M. S. McClure, Connecticut Agr. Exp. Sta., New Haven, CT 06504.

*Fiorinia externa* is a destructive pest of *Tsuga canadensis* (L.) Carrière in southwestern Connecticut where it also infests 43 species of exotic cedar, fir, hemlock, pine, spruce, and yew. First instars (crawlers) were dispersed by the wind for more than 100 m and preferentially colonized the youngest needles in the lower crown of hemlocks on which they fell. Various edaphic conditions characteristic of sites where hemlock grows naturally significantly influenced survival and development of colonists. Paratitism of second and third instar females by *Aspidiotiphagus citrinus* Craw. (Hymenoptera: Eulophidae) frequently was 50% but in some areas reached 96%. Parasitism was density-dependent within and among hemlock crowns and increased with scale density for three generations. Thorough coverage of foliage with dimethoate insecticide provided excellent scale control (99% mortality). However, partial coverage favored the resurgence of populations

by increasing the rate of development and fecundity of surviving scales while reducing mortality from natural enemies. Population growth was retarded on hemlocks supporting high densities of feeding nymphs. These studies on distribution, alternate hosts, and dispersal establish a basis for predicting the rate of spread of *F. externa* in the Northeast. The investigations on the response of natural enemies to scale density and on the effects of insecticide treatment and of environmental- and herbivore-induced stress of hemlock on scale population growth provide a means for determining the most effective measures for controlling *F. externa* in the hemlock forest.

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Sexual Interference as a Displacement Mechanism in *Aedes* (Diptera: Culicidae) Mosquitoes.—I. N. McDaniel and M. D. Bentley, Univ. Maine, Orono, ME 04473.

While conducting studies on oviposition attractants for *Aedes triseriatus* in a large cage, we found that the introduction of small numbers of *A. aegypti* led to a rapid collapse in the *A. triseriatus* population. Displacement by another species is generally regarded to be due to competition for food and space. However, in this case it appears to be due to sexual interference, since the males of *A. aegypti* were seen mating with the other species. These species do not hybridize, but it appears that the transfer of matrone from *A. aegypti* males prevents *A. triseriatus* females from mating with conspecific males. Proof of cross mating was established by finding sperm in spermathecae of *A. triseriatus* females caged with males of *A. aegypti*. These females had been isolated singly as pupae to prevent contact with conspecific males. Our data indicate that *A. triseriatus* cannot coexist with *A. aegypti* where the latter are present in cross mating, but in each case *A. triseriatus* was eliminated by the third generation. It is suggested that field releases of suitable strains of *A. aegypti* might result in eradication of isolated populations of *A. triseriatus* in areas where La-Crosse virus is enzootic. In northern areas, the *A. aegypti* would not survive the winter. Releases of males might suffice in the south.

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Passive Dispersal of the European Skipper, *Thymelicus lineola* (Ochs.) (Lepidoptera: Hesperiidae), an Insect Pest of Hay Crops.—J. N. McNeil and R. M. Duchesne, Univ. Laval, Québec, P.Q. Canada.

The European skipper, *Thymelicus lineola*, has recently become a serious pest of hay grasses in several Canadian provinces and in the state of Michigan. As the adults are weak fliers the possible importance of passive

transport of eggs (containing diapausing 1st stage larvae) has been alluded to but never studied. Hay bales bought in an area of heavy infestation in 1975 were found to contain over 5,000 viable eggs/bale. This is considered a conservative estimate as egg mortality (≥50%) was considerably higher than in other years (≈20%), due to an extremely dry period following oviposition. Eggs infested by cattle did not survive. The possibility that certified timothy seed may contain eggs was also considered. The waste obtained following the post harvest cleaning process was heavily infested (2,000 eggs/kg) but the number found in the certified seed was negligible. However the waste is either sold or given away as uncertified seed. Considering the high densities of eggs and the wide scale movement of hay and uncertified seed we believe that the passive transport of *T. lineola* eggs is the principal means of dispersal for this pest. It is therefore recommended that all waste material from the certified seed cleaning process be destroyed, and that the possibility of limiting the shipment of hay from infested areas be considered.

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Nocturnal and Diurnal Movements of Beneficial Insects in a Potato Field.—T. P. Mack and Z. Smilowitz, Pennsylvania State Univ., University Park, PA 16802.

The nocturnal and diurnal movements of the predaceous natural enemies of the green peach aphid, *Myzus persicae* (Homoptera: Aphididae) were investigated in potato (*Solanum tuberosum* L. var. *katahdin*) fields in order to develop a valid sampling scheme. These movements were determined by the weekly sampling of 36 clear flat plastic sticky traps during July and August. Each of the vertically aligned 91.5 × 21.0 cm sticky traps were placed 2 inches above the soil level. Counts of insects and their location on the traps were taken at three intervals between 2130–0930, 1030–1330 and 1415–1600 h. The most abundant predators found were coccinellids (Coleoptera: Coccinellidae), chrysopids (Neuroptera: Chrysopidae), and syrphids (Diptera: Syrphidae). The average number of coccinellids caught/h during the sample periods was 11.5 ± 16.09, 8.64 ± 4.52 and 19.85 ± 9.06. Smaller numbers of chrysopids and syrphids were found: 1.48 ± 1.48, 0.84 ± 0.49, 0.5 ± 0.5 and 0.4 ± 0.3, 1.56 ± 1.0, 1.5 ± 1.37. The least movement and variation for the coccinellids occurred during the 1030–1330 h sampling period, while the least movement for chrysopids and syrphids occurred during the 1030–1330 and 2130–0930 h periods, respectively. Seventy-six percent of the coccinellids caught were on the middle and lower trap heights (890/1,156) while 76.2% of the chrysopids (64/84) and 76.8% of the syrphids (53/69) caught were on the middle and upper trap heights.

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Histoblasts: Localization and Growth Dynamics in the Young Larvae of *Drosophila melanogaster* (Diptera: Drosophilidae).—M. M. Madhavan, Univ. California, Irvine, and Holy Cross College, Worcester, MA 01610.

The freshly hatched *Drosophila* larva is a mosaic organism consisting of both the larval and imaginal cells. The presumptive integument of the adult head, thorax and genitalia is represented by imaginal discs and that of the adult abdomen by nests of cells, the histoblasts. The changes occurring in imaginal discs during postembryonic stages have been studied in great detail. However, information regarding the developmental changes occurring in the histoblasts during the early stages of postembryonic development is scanty. Furthermore, histologically, the presence of histoblasts in the newly hatched larvae has never been demonstrated. By histological techniques I have shown that each abdominal hemisegment of a young larva consists of an anterior dorsal, posterior dorsal and a ventral histoblast nest containing about 13, 6 and 12 cells respectively. The number of cells in each histoblast nest remains almost the same from the time of larval hatching until 5 h after pupariation when they begin to proliferate rapidly. This behavior is in contrast with that of the histoblasts of other dipterans studied in which they begin to divide during the second instar. The histoblasts increase in volume about 60-fold and their nuclei show an increase of about 25-fold between the time of larval hatching and pupariation.

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A Review of Maple Bark Scale, *Cryptococcus williamsi* Krb. and Hale (Homoptera: Cryptococcidae), in New Hampshire.—A. H. Mason, Univ. New Hampshire, Durham, NH 03824

A new scale insect on sugar maple, *Acer saccharum*, was found in New Hampshire on December 30, 1965 following its initial discovery in Vermont during 1964. The scale was described by Michael Kosztarab and Dreamer L. Hale in 1967 and named *Cryptococcus williamsi* Krb. and Hale with a suggested common name, maple bark scale. Because of the recognized damaging association of beech scale, *Cryptococcus fagi-Nectria* to American beech and the importance of sugar maple to the economy of portions of the United States, cooperative and coordinated investigations were initiated by many state and federal agencies to establish the distributional limits, biology and host relationships of *C. williamsi*. Although the principal host of *C. williamsi* is sugar maple one observation was made of this scale on red maple, *Acer rubrum*. The maple bark scale was found to be widely distributed throughout New Hampshire. The maple bark scale was detected in association with a *Nectria* fungus with fruiting bodies similar to *Nectria coccinea* var. *faginata* Loh. of beech on two of 74 areas examined

in the White Mountain National Forest. Only five infected trees were observed. Parasites, *Coccophagoides* sp. (Aphelininae: Eulophidae), were reared from the maple bark scale. Although no immediate threat of a maple bark scale-*Nectria* association damaging to sugar maple is apparent, continued studies and investigations are recommended.

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Emergence of Alfalfa Blotch Leafminer Adults, *Agromyza frontella* (Rondani) (Diptera: Agromyzidae).—W. K. Mellors and R. G. Helgesen, Cornell University, Ithaca, NY 14850.

The objective was to develop a predictive model of alfalfa blotch leafminer adult emergence. The leafminer overwinters in New York as puparia in the soil. Development in the spring proceeds as heat unit accumulation after warming of the soil. Laboratory incubation of nondiapausing pupae at constant temperatures provided developmental times and rates for males and females. Nonlinear developmental models were fit to the data. Developmental thresholds were less than 10°C. Females developed slightly faster than males at the same temperatures and required from 15 days at 25°C to 60 days at 10°C. Daily maximum and minimum soil temperatures were used as inputs to the developmental model to sum development over time and predict adult emergence in the field in the spring. Aside from sex differences in developmental rates, 3 factors tended to spread out the adult emergence of puparia in the soil, the changes in soil temperature with soil depth, and the distribution of developmental rates within the leafminer population. To account for this expected variability, the field population puparia were stratified by developmental rate, soil depth, and sex prior to estimation of individual emergence dates. These were combined into an overall emergence pattern.

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In Vitro Rearing of Larval Southern Pine Beetles, *Dendroctonus frontalis* Zimmerman (Coleoptera: Scolytidae), on tissue-cultured loblolly pine callus. —R. L. Mott, North Carolina State Univ., Raleigh, NC 27607; H. A. Thomas, U.S. For. Ser., Research Triangle Park, NC 27709 and G. Namkoong, U.S. For. Ser., Raleigh, NC 27607.

Efforts to study the nutrition of the southern pine beetle have been prevented by our inability to rear it free of its normal microbial associates, some of which are thought to contribute to its nutritional requirements. Although attempted at various times in the past, development of an aseptic rearing technique has been unsuccessful. The objective of this study was to evaluate tissue-cultured callus of phloem from one of the beetle's prin-

cipal hosts, loblolly pine *Pinus taeda* L., for its ability to sustain larval growth and development. The results showed that aseptic beetles could be produced on callus on 3% agar and that the addition of β-sitosterol to the substrate enhanced the rate of development. Callow adults were obtained in 35–65 days at about 22°C. Approximately 17% of the larvae completed their development. Free moisture or higher temperatures were harmful. The adults were slightly smaller than normal and efforts to obtain mating have been unsuccessful so far. The results suggest that the relationship with the concomitant microorganisms is not obligatory if a sterol source is provided. The sterol content of unfortified callus has not been determined.

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Isolation and Partial Characterization of Uric Acid Crystals Obtained from Cockroach Tissues (Dictyoptera).—D. E. Mullins, VPI and SU, Blacksburg, VA 24061.

Internal storage of uric acid in cockroaches has been observed by many workers. These internal reserves are apparently in a dynamic state since they are stored/mobilized in response to dietary nitrogen levels. There is evidence that uric acid is stored as urate salt(s) of K, Na and perhaps $NH_4$ because in many instances whole body uric acid content can be correlated with K, Na and nitrogen levels. Urate crystals have been removed and purified from cockroach tissues by tissue disruption in nonaqueous media and separated from cellular debris by filtration and centrifugation through immersion oil columns. Visual examination of the isolated urate crystals using light microscopy has revealed that they are round spherules, ranging from about 5–40 μm in diameter and display a characteristic birefringence under polarized light. Scanning electron microscopy revealed that although most of these crystals are smooth spherules, a few of them display a multilobed appearance. Results obtained using microprobe analysis indicated that the spherules were high in K, but Na content was low. Infrared spectra obtained from isolated spherule preparations displayed a characteristic pattern different from various urate standard preparations. Examination of these spherules using transmission electron microscopy indicate that they consist of a homogeneous matrix with a dense, dark-staining center which might be of importance in the initiation of urate crystal growth. Studies of the precise composition and the dynamics of urate storage/mobilization may provide useful information on the formation and growth of biological crystals.

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Separation and Quantitation of the Norsequiterpenes from Gyrinid Defensive Secretions Using High-pressure Liquid Chromatography.—A. T. Newhart and R. O. Mumma, Pennsylvania State Univ., University Park, PA 16802.

High-pressure liquid chromatographic (HPLC) separations of the gyrinid norsequiterpenes, isogyrinidal, gyrinidal, gyrinidione and gyrinidone have been developed. Good separations were achieved with a normal phase column ($\mu$Porasil) using a choloroform:hexane solvent system and for a reversed phase column ($\mu$Bondapak $C_{18}$) using an acetonitrile:water solvent system. These methods were rapid, sensitive, stable and suitable for quantitative studies. The applicability of these methods was demonstrated when the norsequiterpenes of the defensive secretions of the aquatic beetle *Gyrinus frosti* were isolated and identified as isogyrinidal and gyrinidal. The defensive titer of *G. frosti* and *Dineutus assimilis* were studied over a 5-month period. A large variation exists in the defensive titer between individuals of the same species, and the average titer of a species fluctuates seasonally.

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Host Finding and Trapping of European Apple Sawfly, *Hoplocampa testudinea* (Hymenoptera: Tenthredinidae).—E. D. Owens and R. J. Prokopy, Univ. Massachusetts, Amherst, MA 01003.

The European apple sawfly (EAS) is one of the 5 major pests of apple fruits in southern New England. Little is known of its behavior, and until now, there has been no effective method of monitoring EAS adult populations. On sunny warm days, we studied EAS behavior in unsprayed blooming apple trees. We observed extensive pollen feeding at the anthers and oviposition at the distal end of the flower receptacle. EAS flew frequently, usually landing directly on or beside blooms. Spectrophotometric analysis revealed very low reflectance of any floral components from 300–370 nm, gradually rising reflectance of the petals and stamens from 370–450 nm, and high reflectance of the petals from 450–650 nm (insect-visible spectrum —300–650 nm). Comparisons of EAS responses to 15 × 20 cm sticky coated rectangles hung in the trees showed high EAS captures on zinc oxide and titanium oxide white (both with reflectance spectra very similar to apple blossom petals), some captures on gray and clear plexiglas, and few or no captures on lead carbonate white and aluminum foil (differing from apple blossom petals due to higher reflectance from 300–370 nm). Yellow, green, blue, orange, red and black also captured few EAS. We consider sticky coated zinc or titanium oxide white rectangles to be a promising EAS monitoring device.

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Efficacy of Selected Pesticides Against *Hemerocampa leucostigma* (Smith and Abbott) (Lepidoptera: Lymantriidae).—M. P. Parrella and R. L. Horsburgh, Shenandoah Valley Res. Sta. VPI and SU, Steeles Tavern, VA 24476.

The white-marked tussock moth, *Hemerocampa leucostigma*, was found heavily infesting approximately 300 acres of mature apple trees in Syria, Virginia, during 1976–77. Workers refused to enter the orchard to pick fruit or to remove water sprouts because of skin irritations produced by the hairs of the larvae. In an effort to control this insect with conventional pesticides, we found that current toxicity data for *H. leucostigma* was lacking. As a result, laboratory tests using a number of orchard pesticides at their current recommended dosages were conducted. The following pesticides were evaluated: Guthion 50 WP, Imidan 50 WP, Thuricide HPSC WP, Penncap M 22%, Dipel WP, Lannate L 24% and Dikar WP. These materials can be separated into 2 groups based on the mortality produced. Group I consisted of Guthion, Penncap M and Lannate which consistently resulted in the highest mortality while showing no significant differences among themselves. The second group, made up of Dipel, Thuricide, Imidan and Dikar, produced mortality significantly greater than the control at all recordings past 24 h. However, this mortality was significantly smaller than Group I at all the readings. Dikar, a fungicide and miticide, produced higher mortality at 48 and 72 h than the other members of Group II. To obtain the greatest kill in the shortest period of time, any pesticide in Group I would be satisfactory.

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Possible Character Divergence of Mandible Size and Gape in Sympatric Tiger Beetles (Coleoptera: Cicindelidae).—D. L. Pearson and E. J. Mury, Pennsylvania State Univ., University Park, PA 16802.

Evidence is presented for character divergence in mandible size in seventeen sympatric species of tiger beetles occurring in the Sulphur Springs Valley, Arizona. Feeding trials demonstrate that mandible length is important in determining the upper limit of a cicindelid's prey range. Mandible size may thus be used as an indicator of resource partitioning within the tiger beetle community. Grassland and pond edge habitats are compared. The former supports a meager prey fauna with a considerable size range. The latter contains many prey items of relatively uniform size. Considerable interspecific overlap in both mandible and body lengths is found among species that forage regularly near a permanent pond site. Spatial separation of tiger beetles along the pond edge is likewise minimal. In contrast, grassland cicindelids fall into three size classes—each containing two

species. These pairs can be delineated further on the basis of microhabitat preference, diurnal activity patterns, and prey specificities. Similar divergence occurs among those species occupying marginal habitats or temporary pond edges. Selection for character divergence in areas of probable food limitation has apparently acted to reduce niche width, resulting in the lessening of competitive pressures.

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Monitoring Traps for Tarnished Plant Bug, *Lygus lineolaris* (Hemiptera: Miridae), on Apple.—R. J. Prokopy, R. G. Adams and K. I. Hauschild, Univ. Massachusetts, Amherst, MA 01003.

Adult tarnished plant bugs (TPB) are one of the 5 major pests of apple fruit in New England. Until now, there has been no reliable method for accurately monitoring TPB population levels on apple. Therefore, we compared TPB responses to various hues and shades of 15 × 20 cm sticky-coated rectangles hung from apple tree branches ca. 1 m above ground. Titanium oxide white enamel, clear Plexiglas and Zoecon daylight fluorescent yellow cardboard (ZFY) captured equal numbers of TPB and more than gray, yellow, green, blue, orange, red, or black enamel, aluminum foil, or daylight fluorescent green or orange. Aided by spectrophotometric analysis, we interpret these findings to suggest lack of positive response of appetitive TPB to ultraviolet-reflecting surfaces (analogous to skylight) and surfaces of dark color (analogous to apple twigs and bark). Weekly, from green tip to harvest, we sampled TPB injury on 12 apple trees receiving no insecticidal sprays. On each sampling date on each tree, we also compared 3 methods of monitoring TPB populations: 1) 25 net sweeps of the ground cover under the tree; 2) observation of 25 apple buds or fruits for presence of individual TPB; and 3) number of TPB captured that week on 1 ZFY trap. The first 2 methods proved of little value, since very few TPB were found. The traps captured considerable TPB and proved a useful monitoring device in that fluctuations in TPB trap captures showed high positive correlation with fluctuations in occurrence of TPB injury.

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Development of the Esophageal Bulb of the Apple Maggot *Rhagoletis pomonella* (Walsh) (Diptera: Tephritidae).—S. Ratner and J. G. Stoffolano, Univ. Massachusetts, Amherst, MA 01003.

The esophageal bulb, a possible mycetome of adult *R. pomonella* first appears 8–11 days post-pupation as a simple undifferentiated bud from the foregut, just posterior to the pharynx. By 7–10 days preeclosion, the apical cells of the bulb become elongate, contorted, and basophilic. A thin

intima surrounds the lumen. There are no ultrastructural indications of functional specialization. By 5–6 days preeclosion, the apical cells are tall and columnar, while the remainder of the epithelium retains a low cuboidal form. The proximal third of the bulb is constricted into a neck by a developing layer of circular muscle. The apical membranes of the columnar cells are thrown into folds, with numerous mitochondria and microtubular bundles interspersed among them. There are no significant changes in the morphology and ultrastructure of the bulb from emergence until sexual maturity (2–3 weeks posteclosion), when mitochondrial degeneration becomes apparent. The ultrastructure of the esophageal bulb supports the hypothesis that the apical epithelium absorbs small molecules from the lumen.

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Contact Toxicity of Selected Insecticides to Gypsy Moth *Lymantria dispar* (L.) (Lepidoptera: Lymantriidae) Larva; Larval Parasite, *Compsilura concinnata* Meigen (Diptera: Tachinidae); and Pupal Parasite, *Brachymeria intermedia* (Nees) (Hymenoptera: Chalcididae).—N. C. Respicio and A. J. Forgash, Rutgers Univ., New Brunswick, NJ 08903.

An estimate of the hazards of gypsy moth control materials to parasites can be obtained by comparing the amount required to kill the host with those that are lethal to the parasite. This investigation deals with the relative toxicity of 7 insecticides to third-instar gypsy moth larvae; larval parasite and pupal parasite. The insecticides were evaluated by topical application. Results show that both parasites were significantly more tolerant to trichlorfon, FMC 33297 and SBP 1513 than third instar gypsy moths. Male and female *B. intermedia* were significantly more tolerant to these three compounds than *C. concinnata*. *C. concinnata* were highly tolerant while *B. intermedia* were as susceptible as third instars to acephate and carbaryl. Although CGA 18809 was significantly toxic to third instars, it was also highly toxic to *B. intermedia*. On the other hand, Accothion® was least toxic to third instars but was highly toxic to both species of parasites. Since trichlorfon, FMC 33297 and SBP 1513 were relatively more toxic to gypsy moth larvae and were significantly less toxic to both species of parasites, these compounds are potentially much less hazardous to both parasites than any of the insecticides tested. These data provide information on the inherent toxicities of the various insecticides to a given parasite species and on the differences in insecticide susceptibility between species.

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Method for Assaying Nectar Sugars Produced by Plants and Harvested by Insects.—R. B. Roberts, Rutgers Univ., New Brunswick, NJ 08903.

The energetic relationships between plants and nectar gathering insects is basic to studies of foraging behavior, as well as to the applied aspects of crop pollination and honey production. The standard microcapillary technique for assaying nectar for sugar is inaccurate and tedious. Furthermore, it is useless for plants with minute flowers, such as the Compositae, or plants with very viscous nectar, such as cranberries. The colorimetric method for assaying microgram amounts of sugar in solution developed by Dubois, et al. has been adapted for determining the amounts of sugar produced by plants and harvested by insects. The procedure is basically as follows: 1) rinse flower (or macerated insect) in known amount of water and merthiolate; 2) place 1 ml rinse soln in test tube; 3) add 1 ml 5% phenol soln; 4) add 5 ml conc $H_2SO_4$; 5) measure absorption of soln at 480–490 m$\mu$ with spectrophotometer. Reagents are inexpensive, relatively stable, and universally available. Hundreds of samples may be assayed per day. The technique has been used to measure: 1) total sugar production in 4 different types of plants; 2) rate of sugar production in these plants; 3) total sugar harvested by insects; 4) rate at which insects harvest sugar; 5) harvesting efficiency of individual insects.

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Alternate Methods of Cockroach Control: Genetic.—M. H. Ross, VPI and SU, Blacksburg, VA 24061.

Genetic studies have laid the foundation for investigating genetic control of the German cockroach, *Blatella germanica* (L.). Reciprocal translocations were selected as the most promising of the available mechanisms. The genetic load imparted by single translocation-carrying males cannot alone suppress population growth, but double translocation heterozygotes have this capability. Their effectiveness depends on a combination of lethality derived from unbalanced gametes and sterility arising from embryonic trapping (inability of low numbers of viable embryos to force open the ootheca at the time of hatch). Synthesis and study of 3 double translocation stocks showed similar properties in 2 which combined independent translocations, including 70% sterility from trapping. Males of the third double stock, a 3-chromosome type, showed sterility in 90% of the oothecae in crosses to wild-type females. All 3 showed equal competitiveness with laboratory wild-type males in 1:1 mating tests. Sequential releases of 4-chromosome double males suppressed growth of a laboratory population. However, the 3-chromosome double is a better

mechanism, due both to higher sterility and to progeny genotypes (all are translocation heterozygotes). The establishment of productive intercross systems as sources of double males with considerably higher lethality and sterility than in the parental matings is possible due to sex differences and changes in the frequencies of alternate vs. adjacent chromosome disjunction. The 3-chromosome double approaches complete sterility but other stocks currently on hand may be manipulated to achieve this goal which is estimated to occur at ca. 80% lethality.

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Varietal Preferences of the Eastern Raspberry Fruitworm *Byturus rubi* Barber (Coleoptera: Byturidae).—G. A. Schaefers and B. H. Labanowska, NYS Agric. Expt. Sta., Geneva, NY 14456.

Bud feeding damage by adults was evaluated among 30 replicated varieties of red raspberries for 2 seasons. Bud damage, which is frequently overlooked by growers, exceeded 25% with certain varieties. Generally, percent injury was related to earliness of fruiting. This is characteristic of the first fruiting period of "fall-bearers." Exceptions included 'Indian Summer' which was lightly damaged. 'Heritage' was also lightly damaged, but this "fall-bearer" is an exception to the early fruiting characteristic. Late-fruiting "summer" varieties generally sustained less severe injury. An exception was the variety 'Latham.' Larval infestation levels were determined in the same planting for 4 seasons. Infestation in some varieties exceeded 40%. In general, the earliest fruiting varieties had the highest infestation levels. Adult concentration on these varieties would account for increased oviposition and the resulting larval infestation. No variety appeared to offer useful levels of resistance to the larvae. The results indicate that annual cropping of "fall-bearing" varieties would provide an escape from this pest problem.

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Influence of *Myzus persicae* (Sulzer) (Homoptera: Aphididae) Infestations of Flue-cured Tobacco Yield and Quality.—P. J. Semtner, VPI and SU, Blackstone, VA 23824.

The effects of time and rate of green peach aphid, *Myzus persicae* (Sulzer), infestation on flue-cured tobacco yield and quality was investigated in Virginia during 1976. Experimental tobacco was artificially infested with nymphal and apterous adult aphids. Artificial infestations were made at 3, 5½ and 8 weeks after transplanting. Two separate releases were made 8 weeks after transplanting. The first received 50 aphids/plant and corresponded to release levels in the 3- and 5½-week post-transplant releases, while the second received 500 aphids/plant. The artificial

releases were compared to a natural infestation and to a treatment where aphids were controlled using foliar applications of malathion. Aphid populations increased rapidly on tobacco infested at 3 and 5½ weeks after transplanting and on naturally infested tobacco. Populations in the two 8-week post-transplant releases remained near release levels before beginning to decline 2–3 weeks after infestation. Aphid populations on the naturally infested tobacco declined more rapidly than did those on tobacco infested 3 and 5½ weeks after transplanting. Tobacco infested at 5½ weeks had 15% lower yield and value/ha than the control, while the 3-week post-transplant treatment had 6 and 9% lower yields and value/ha, respectively, than the control. These two treatments had significantly lower yield and values/ha than the other treatments, which were not significantly different. Tobacco infested at 3 weeks after transplanting had a value of 4 to 9¢/kg lower than the other treatments.

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The Attack Response of *Efferia tricella* (Diptera: Asilidae) to Eight Tiger Beetle Species (Coleoptera: Cicindelidae).—T. E. Shelly and D. L. Pearson, Univ. Delaware, Newark, DE 19711 and Pennsylvania State Univ., University Park, PA 16802.

Past studies of the predaceous habits of adult asilids have generally been simple listings of prey species. More recently, asilid/prey size relationships have been quantified, yet for only one asilid species has prey recognition and hence relative vulnerability among prey items been examined. The overlap in temporal and spatial distribution between *Efferia tricella* and eight tiger beetle species indicated the importance of morphological and/or behavioral predator avoidance adaptations. Based strictly upon morphological characteristics, the vulnerability of the various beetle species was measured by recording (as strike or non-strike) the responses of individual asilids to tethered beetle specimens. The results indicated (1) asilid attack response was inversely correlated with body size and (2) the orange abdomen characteristic of two beetle species reduced strike frequencies below that observed for similarly sized specimens with black abdomens. Coating the orange abdomens with black paint resulted in increased strike frequencies, and conversely application of orange paint to a species with a black abdomen reduced strike frequency by nearly half. Thus, in a situation in which prey do not avoid predation by escape in time or space, large body size and orange coloration appear to effectively reduce asilid predation. These findings contribute toward an understanding of those factors which elicit asilid attacks and the subsequent vulnerability of potential prey items which necessarily underlies all comparisons of actual and available prey.

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Evolution of Reproductive Isolation Between the Neotropical Butterflies *Anartia fatima* F. and *A. amathea* (Lepidoptera: Nymphalidae).—R. E. Silberglied and A. Aiello, Harvard Univ. and Smithson. Trop. Res. Inst., Box 2072, Balboa, Canal Zone.

The final event in true speciation is the evolution of prezygotic isolating mechanisms that prevent interspecific mating. Two species of *Anartia* that hybridize naturally in eastern Panama were studied by laboratory hybridization, including all possible backcrosses and F2 combinations of the 2 reciprocal F1 hybrids to the parental species and to one another. Strong postzygotic isolation in the form of hybrid breakdown, slower larval development and anomalous mating behavior, were observed in the second generation. Butterflies from sympatric and allopatric populations were then examined for the presence or absence of behavioral (prezygotic) isolating mechanisms. The results, compared with random samples of these species and their hybrids from the area of sympatry in eastern Panama, demonstrate the evolution of behavioral isolation where the 2 species occur together.

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Sampling and Distribution of Potato Leafhopper Nymphs in Alfalfa.—D. E. Simonet and R. L. Pienkowski, VPI and SU, Blacksburg, VA 24061.

A sampling technique using quart ice cream cartons containing ca. ¼″ vapona squares was used to sample potato leafhopper nymphs in alfalfa. Laboratory tests showed that 91.1% of potato leafhopper nymphs can be easily extracted from groups of 3 stems after 24 h exposure in the cartons. Using this technique, stems were collected in two fields in Montgomery Co., VA to determine distributional patterns of potato leafhopper nymphs in alfalfa. The basic sampling unit was a 3 stem bouquet. Eighty groups of 3 stems were collected from each field at least every 2 weeks. Samples were counted and instar determinations were made in the laboratory. During most sampling periods there were not enough frequency classes in the population data to test distributional patterns. However, those data which could be tested showed that nymphs were distributed in an aggregated pattern following the negative binomial model. Sample sizes were determined based on this model using the coefficient of variation as a reliability parameter for levels of accuracy at 10, 20, and 30% of the mean. This technique is useful since samples can be quickly collected in the field, and nymphs can be easily counted and separated to instar in the laboratory.

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Effects of the Nuclear Polyhedrosis Virus of *Lymantria dispar* (L.) [Lepidoptera: Lymantriidae] on the Endoparasite *Apanteles melanoscelus* (Ratz.) [Hymenoptera: Braconidae]: an Ultrastructure Study.—R. P. Smith and J. B. Simeone, SUNY College of Environmental Science and Forestry, Syracuse, NY 13210.

Fourth instar gypsy moth caterpillars containing the endoparasite, *Apanteles melanoscelus*, were fed an artificial diet containing 107 polyhedral inclusion bodies. After 10 days, endoparasites were dissected from their hosts and processed for light and transmission electron microscopy in the following manner: midguts or diced *Apanteles* larvae were fixed for 2 h in cold 1.5% glutaraldehyde in Sorenson's phosphate buffer (pH 7.2) with sucrose added, washed in buffer and post-fixed for 3 h in 2% osmium tetroxide. Tissues were stained overnight in 1% uranyl acetate, dehydrated in a graded series of ethanols and embedded in Spurr's resin. Sections were cut on a Porter-Blum MT-2 ultramicrotome and post stained with lead citrate. A Zeiss Universal microscope was used to examine thick sections while an RCA EMU-4 electron microscope operated at 100 kv examined adjacent sections. Optical and electron micrographs revealed polyhedra associated with host tissue fragments in the parasite midgut. Also, polyhedra and isolated nucleocapsids rest among the microvilli projecting into the lumen. In the hemocoel, polyhedra were enclosed within degenerating fat and blood cells of the parasite. Here, some polyhedra exhibited the densely stained periphery indicating they were formed within virus infected tissues. The mechanism by which polyhedra penetrated into the hemocoel is unknown, although abnormalities in the parasite nuclei and cytoplasm of the midgut suggest that the host disease may adversely affect the parasite.

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The Effectiveness of Chlorofluorocarbon and Hydrocarbon Propelled *d*-phenothrin in Aerosols Against Biting Flies.— W. N. Sullivan and B. M. Cawley, Beltsville Agri. Res. Center, ARS, USDA, Beltsville, MD 20705.

The Beltsville Agricultural Research Center, Beltsville, MD, has been interested in the developing family of pyrethroid insecticides since Schechter and LaForge synthesized allethrin. Sumithrin (*d*-phenothrin) (3-phenoxybenzyl *d-cis* and *trans* 2,2-dimethyl-3-(2-methylpropenyl) cyclopropanecarboxylate), one of the newest pyrethroids, was selected for this study because it has excellent environmental qualities. Two aerosol formulations were prepared commercially: (1) 2% *d*-phenothrin in chlorofluorocarbons 11 + 12 (1:1), and (2) 2% *d*-phenothrin in $H_2O$, liquid propane/isobutane, and an emulsifier. Both formulations, when applied at a dosage of 0.91 to 1.2 g in

28.3 $m^3$ chambers (no air conditioning) gave a 96–100% mortality of *Anopheles stephensi* Liston, *Aedes aegypti* (L.), *Culex pipiens quinquefasciatus* Say, and *Stomoxys calcitrans* (L.). Both formulations at 5 g/28.3 $m^3$ gave a 100% mortality of *Tabanus lineola* Fabricius. In actual and simulated aircraft disinsection tests (complete air exchange every 3–4 min) a 5 g/28.3 $m^3$ dosage of formula 1 gave a 100% mortality of *Glossina morsitans* Westwood and *Simulium vittatum* Zetterstedt. The proposed Environmental Protection Agency rules prohibiting the use of chlorofluorocarbons as propellants in self-pressurized containers grants essential-use exemptions to flying insect pesticides for use in nonresidential food handling establishments and poultry coops; and for space spraying of aircraft.

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Fine Structure of the Fat Body of *Aedes aegypti* L. (Diptera: Culicidae) During Vitellogenesis.—T. M. Tadkowski, Univ. Maryland, College Park, MD 20742.

An increasing number of biochemical studies concerning the extraovarian synthesis of vitellogenins have prompted a morphological investigation into the ultrastructure of the fat body of female *A. aegypti* during vitellogenesis. The adipocytes contain many large lipid droplets, numerous mitochondria large fields of glycogen, protein inclusions, microtubules and numerous free ribosomes, but possess very little rough endoplasmic reticulum (RER) at the time of adult emergence. After a 4-day starvation period (water only), the lipid and protein content is diminished, and cytolysosomal figures appear in the fat body cells. Seven hours after the female takes a blood meal, the oocytes begin rapidly filling with protein yolk, and the adipocytes begin to form additional RER, and large prominent nucleoli appear. The oocytes contain a significant amount of RER and numerous free ribosomes during the first 14 h post blood-meal, which suggest that the fat body may not be the only source of protein yolk during the early stages of vitellogenesis. The adipocytes synthesize increasingly larger amounts of RER during the next 17 h, although no storage of protein was seen. Starting at 24 h and continuing to 35 h after the blood-meal the flocculent material in the RER cisternae seems to pass into Golgi-like complexes. By 48 h post blood-meal, adipocytes possess little RER but contain numerous mitochondria. They both surround the nucleus. The nucleoli appear to "fragment" at this time. Many cytolysosomes, substantial amounts of glycogen and large clear areas in the cytoplasm are also present.

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Initial Field Tests Using Commercial *Bacillus thuringiensis* Berliner to Control the Variegated Leafroller *Platynota flavedana* Clemens (Lepidoptera: Tortricidae).—J. H. Thomas & C. H. Hill, VPI and SU, Winchester Fruit Res. Lab., Winchester, VA 22601.

In 1974, the variegated leafroller, *Platynota flavedana*, damaged 47.2% of the unsprayed apples in an orchard in Winchester, VA. Control of the pest was attempted using dilute sprays of 4 different treatments of *Bacillus thuringiensis* (Thuricide 16B 8 BIU, Thuricide HPC 8 BIU, Dipel 7.26 BIU, Dipel 3.63 BIU/100 gal). Each treatment was applied to 5 single tree replicates at 2-week intervals starting on July 8 and ending Sept 9. The treatments were evaluated in Aug and Sept by timed counts of larval habitats and at harvest by examination of the fruit. The number of apples damaged ranged from 4.8% for Thuricide 16B to 12.4% for Thuricide HPC. In the same orchard *P. flavedana* larvae damaged 46.4% of the untreated apples in 1975. Dilute treatments of *B. thuringiensis* were applied at 2-week intervals beginning June 17 and ending Aug 27. The experimental design was the same as in 1974. Evaluations of the treatments were made by examining the contents of 50 leafrolls per tree (or as many as could be found) in Aug and Sept, and by examination of the apples at harvest. The amount of damage ranged from 0.8% for Dipel at 7.26 BIU to 7.2% for Thuricide HPC at 8 BIU/100 gal. The combination of Thuricide HPC 4 BIU + Fundal SP .25 lb/100 gal restricted the damage to 1.6% of the apples examined. These results suggest that experimentation with *B. thuringiensis* be continued to determine the proper rates, formulations, combinations with other materials, and timing of applications to control *P. flavedana*.

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Laboratory Evaluation of the Synthetic Pyrethroid Ectiban (Permethrin) for Control of *Musca domestica* L. (Diptera: Muscidae).—L. Townsend, Jr. and E. C. Turner, Jr., VPI and SU, Blacksburg, VA 24061.

Ectiban was evaluated as a feed additive, larvicide, residual surface spray, and treated cotton cords for potential use in caged-layer poultry houses. Ectiban at 5 and 10 ppm ai in larval media controlled 1st and 2nd-instar fly larvae. However, an encapsulated formulation of the pyrethroid fed to hens did not produce comparable results. A bioassay of acetone extracts of feed samples from a test bird indicated that most insecticidal activity was lost in the small intestine. Fly production was greatly reduced in trays of manure seeded with fly eggs following topical applications of the pyrethroid at 24, 48 and 96 mg ai/ft$^2$. A wettable powder and emulsifiable concentrate were sprayed on unpainted, latex- and enamel-painted plywood panels and styrofoam at the rate of 2 mg ai/ft$^2$. Residual

performance of the two formulations on these surfaces was compared by exposing adult flies to the unweathered panels after selected time periods. The EC was ineffective on the painted panels. The WP was effective on latex for 30 days and on enamel for 45 days. Both formulations remained toxic on styrofoam and unpainted plywood for over 50 days. Caged flies were exposed for 1 h to cotton cords treated with 1% or 5% ECTIBAN. Mean percent knockdowns were 76 and 95; mean percent mortalities after a 24 h recovery period were 45 and 61, respectively. ECTIBAN is a potent insecticide. It demonstrated a potential as a tool in the pest management of fly pests in poultry houses.

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Comparison of Thistle-reared Versus Diet-reared *Ceuthorrhynchidius horridus* (Panzer) (Coleoptera: Curculionidae).—J. T. Trumble and L. T. Kok, VPI and SU, Blacksburg, VA 24061.

Subsequent to the development of nutritionally adequate diets, comparisons (*t*-test at 1% level) were made between weevils raised on diets and on musk thistle rosettes. Differences in egg sizes were not significant. Egg viability ranged from 69.0% (plant-reared adults) to 79.7% (diet-reared adults), indicating that diet-reared weevils are as fertile as those reared on musk thistle. A diet-reared ♂ mated with a plant-reared ♀ produced eggs with a 70.0% hatch rate. First instar head capsule widths were not significantly different for larvae from diet-reared versus plant-reared adults. Although 28 day old larvae from rosettes weighed significantly more than those from diets, the latter were not significantly different from larvae produced from plants in a previous study. This suggests: 1) a deviation in host suitability between rosettes used for this and the previous test; 2) that variation in larval growth rates requires large sample sizes for statistical accuracy; 3) dissimilar environmental conditions (other than temperature) could have affected larval developments; or 4) a combination of the preceding. Comparison of adult sizes revealed that plant-reared weevils were significantly larger than diet-reared weevils. Although environmental conditions for adult development were different, smaller adult sizes resulting from diets imply nturitional defects in the artificial media. This apparent defect remains the foremost obstacle to a "mass" production program for *C. horridus*.

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The Importance of the Lesser Appleworm, *Grapholitha prunivora* (Lepidoptera: Olethreutidae) in New Hampshire Apple Orchards.—J. P. Turmel and G. T. Fisher, New Hampshire Agri. Expt. Sta., Durham, NH 03824.

During the months of April through September 1975, a study was conducted on the occurrence, distribution and adult population levels of certain apple Tortricids and Olethreutids in NH. Based on data received from the fruit infestation studies, the lesser appleworm can be considered an economic threat of apple in NH. In abandoned orchards, the population density of this species is extremely high. An average of 10.8% of the surveyed fruit on July 25, 1975 were infested by the lesser appleworm. This, when compared to the known economic species from previous records of the red-banded leafroller and the codling moth, where infestation levels were 1.42% and 8.59% respectively, shows the lesser appleworm to be a genuine economic threat potential. In harvested apples of September, the lesser appleworm infested 22.4% of the evaluated fruit while the red-banded leafroller and the codling moth infested 7.33% and 27.84% respectively. The potential for economic damage to an orchard is definitely present with the existence of the lesser appleworm in NH. Fortunately, present spray programs coincide with the adult flight periods. If present spray programs of apple in NH are altered or changed without consideration of the lesser appleworm, severe infestations by this olethreutid could cause heavy economic losses to the NH orchardist.

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Breeding Habitats of *Culicoides* (Diptera: Ceratopogonidae) and Factors Affecting their Development.—E. C. Turner Jr., VPI and SU, Blacksburg, VA 24061.

Worldwide interest in the genus *Culicoides* has been increasing. These annoying biting midges have been reported to transmit a number of diseases in mammals and birds. Investigations of their breeding habitats show that the larvae live in a variety of aquatic and semi-aquatic substrates. These studies consist not only of general descriptions of breeding sites but also the physical, chemical and nutritional characteristics of the substrates. Attempts have been made to group species by these habitat types. Factors that affect larval development are moisture, temperature, diet, and physical properties of the substrate. Low temperature slows larval development and high temperature causes some species to go into aestivation. Microorganisms commonly found in the habitat site must be available. Proper substrate is necessary to provide cover and protection. Intensity and length of light can also be a factor.

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Determination of Constant Temperature Developmental Thresholds for *Myzus persicae* (Sulzer) (Homoptera: Aphididae).—M. E. Whalon and Z. Smilowitz, Pennsylvania State Univ., University Park, PA 16802.

An initial step in dynamic-deterministic model building has been to derive the function(s) relating physiological development of an insect to a measurable environmental parameter(s). Degree days centigrade (°D) unite insect development to a temporal-heat unit parameter. °D have been calculated in many ways, but the computerized, modified sine wave technique provides one of the most accurate. Utilization of this technique requires the determination of both lower (LDT) and upper (UDT) developmental thresholds. Three temperature regimes were programmed in constant temperature chambers for the LDT (3, 5 and 7 ± 1°C) and the UDT (29, 31 and 33 ± 1°C). Ninety-eight first instar *M. persicae* were individually maintained in each regime on 1.5 cm potato leaf discs (*Solanum tuberosum* L. var. *katahdin*) floating in a potassium-nitrogen-phosphorus solution. Longevity, duration of nymphal stadia and offspring produced were recorded every 8 h. The LDT was 4 ± 1°C as development occurred at 5°C, but not at 3°C. At 5°C, 5% of the test aphids reached the adult stage, producing 15 offspring (1.66 offspring/individual). The mean instar period at 5°C was 34.68 ± 2.771°D. Mean instar period at 7°C was 33.77 ± 2.940°D, with 46% reaching maturity (7.33 offspring/individual). The UDT was 30 ± 1°C since maturation and reproduction occurred at 29°C but not at 31 or 33°C. At 29°C the mean instar period was 32.70 ± 1.916°D and 13.9% of the individuals reproduced (2 offspring/individual).

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Relative Toxicity of Five Insecticides to Larvae of *Dermacentor variabilis* (Say) (Acarina: Ixodidae).—D. J. White and J. L. Benach, New York State Health Dept., Health Sciences Center, SUNY, Stony Brook, NY 11794.

The toxicity of 5 insecticides to *D. variabilis* larvae was tested by exposing the larvae to treated surfaces. LC and LC values, derived by probit analyses, showed that noled was approximately 100 times more toxic to larvae than either propoxur, chlorpyrifos, or pyrethrins and 1,000 times more toxic than ronnel. The LC values in ppm of noled, propoxur, chlorpyrifos, pyrethrins and ronnel at 24 h were, respectively, 0.025, 0.635, 2.394, 2.645 and 24.700. These representative data indicate that the concentrations of insecticide surface residues effective for larval control in the laboratory were less than concentrations recommended by the pesticide manufacturers for field applications to other arthropods. Any insecticide concentration capable of controlling *D. variabilis* adults will also provide significant larval mortality if the application for adult ticks is made to coincide with peak

larval populations. Optimally-timed field applications aimed to immature stages of the tick can contribute to the reduction of the total tick population in subsequent years. Prior to establishing recommendations for field applications of pesticides for tick control, further experimentation is necessary on the toxicity of these and other chemicals on *D. variabilis* adults.

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Pesticide Resistance in Field Populations of German Cockroaches (Dictyoptera: Blattellidae).—F. E. Wood, Univ. Maryland, College Park, MD 20742.

Field resistance of German cockroaches reflects the same symptoms as some other facets of cockroach population behavior, e.g. pesticide misapplication; bad sanitation; reinfestation from uncontrolled areas; differential pesticide breakdown from heat, temperature, incompatible surfaces, etc. All of these conditions are found in urban situations such as public housing. Factors contributing to selection for resistance are large cockroach populations, regular pesticide exposure, variable dosages, unsprayed areas and a routine method of exposing cockroaches to sprayed surfaces. These factors translate into action in the following ways: 1) implementation of vigorous unbending spray schedules (regular exposure), 2) untrained applicators (unsprayed areas, variable dosage), 3) no application in some units (unsprayed areas), 4) routine flushing (method of exposing cockroaches to pesticide) driving some insects into refuges. This action results in a "resistance mill." Similar factors can facilitate the selection for "behavioral resistance" simply if a cockroach is stimulated to activity when it finds itself on a treated surface. Behavioral resistance, which is hard to quantify and recognize, obfuscates a situation where incomplete application or any level of physiological resistance exists. Where an immense cockroach population builds up due to pesticide resistance it seems to take on individual characterizations such as pesticide resistance, while surrounding populations are susceptible; harborage becomes very important; movement into light and out of doors; and aggregating areas. Whether this behavior is due to increased population or not, it raises questions of territoriality, some hierarchy formation or aggression and communication.

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Present Status of Cockroach Resistance and Control: the Pest Species and Their Habitats.—C. G. Wright, North Carolina State Univ., Raleigh, NC 27607.

The German cockroach, *Blattella germanica* (L.), is the dominant domestic species throughout the United States and most other countries. It occurs in

residences, restaurants and many other structures, where it prefers food preparation-serving areas. Three other species, the American cockroach *Periplaneta americana*, the Oriental cockroach *Blatta orientalis* and the brown-banded cockroach *Supella longipalpa*, are also encountered. Americans are often found in the lower confines of structures, especially where warm, damp conditions exist, e.g., in basements of industrial and commercial buildings, steam tunnels and sewers. Orientals prefer crawl areas, basements and damp areas of buildings. Brown-bandeds occur in kitchens, bedrooms, and all other rooms of residences, and occasionally in office buildings, research laboratories and other buildings. Other cockroach species, such as the brown *Periplaneta brunnea*, the smoky-brown *Periplaneta fuliginosa* and the Australian *Periplaneta australasiae*, can infest structures in large numbers. Heavy infestations depend upon the availability of water, food, and shelter; water is the most critical factor for a large population buildup. Brown-bandeds may be an exception to this condition. Sewers can be the locus for structure infestation and reinfestation, especially by American cockroaches. All species, possibly excluding the brown-banded cockroach, can live outdoors in many areas in warmer months, providing a constant source of reinfestation.

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Preliminary Studies of Adult Beetle Populations and Their Bioseasonal Distribution on Natural Vegetation.—W. L. Young and B. R. Rao, East Stroudsburg State College, East Stroudsburg, PA 18301.

The enumeration and seasonal study of insect populations has been studied in detail since the turn of the century. Most work on arthropod populations on natural vegetation is the result of large scale investigation. Variation in the beetle population was studied during the 1975–76 season on the inflorescence of the natural vegetation of a specific area. The peak periods of diurnal activity in the upper herb stratum could be correlated to the subseasonal progress of certain flowering plants. Samples were obtained by the standard sweep net collections and identified to their families and to species in some cases. Following generalizations were made: 1) The fluctuations of different species of beetles may be attributed to the bioseasonal changes in the number of predominant species of flowering plants. 2) The advance, peak and decline of several populations were associated with the floral production of the plant species. 3) The duration of occurrence of certain important beetles as units, together with the appearance of floral succession can be divided into biotic seasons. The studies also reveal the probable alternative host plants of several beetles of some economic importance.

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